No. 5. Vol. 3. ONE SHILLING NET. November, 1903.

PAGE'S MAGAZINE

ENGINEERING · ELECTRICITY
SHIPBUILDING MINING
IRON & STEEL INDUSTRIES

EDITORIAL & PUBLISHING OFFICES, CLUN HOUSE, SURREY STREET, STRAND, LONDON, W.C.

FRANCE, Paris : 22, Rue de la Banque.
GERMANY, Berlin : 5, Unter den Linden.
RUSSIA, St. Petersburg : 14, Nevsky Prospect.
AUSTRIA, Vienna : Kärntnerstrasse, nr 30.

INDIA, Calcutta : Thacker, Spink & Co.
,, Bombay : Thacker & Co., Ltd.
SOUTH AFRICA, Cape Town : Gordon & Gotch.
JAPAN, Yokohama : Kelly & Walsh, Ltd.

CANADA : Montreal News Company.
UNITED STATES, New York : International News Co.
,, Chicago : Subscription News Co.
AUSTRALIA, Melbourne : Gordon & Gotch.

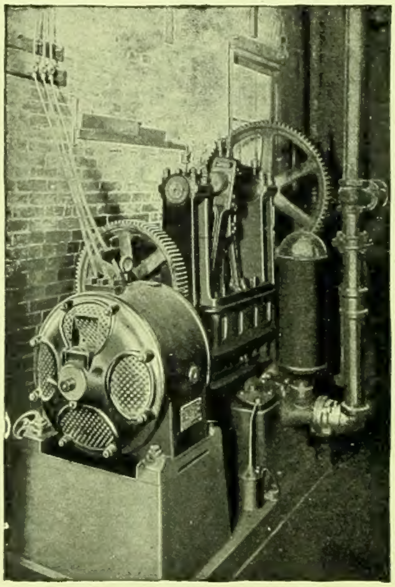
Westinghouse

Induction Motors

Designed to withstand long and continuous runs.

Requires no Skilled Attendance.

Dust and Water-proof.



Westinghouse Induction Motor Operating Pump.

Write for Circular B1070.

The British Westinghouse Electric & Mfg., Co., Ltd.

Head Offices: London, Norfolk St., Strand, W.C.

Branch Offices: Manchester, Glasgow, Sheffield, Birmingham, Newcastle, Cardiff.

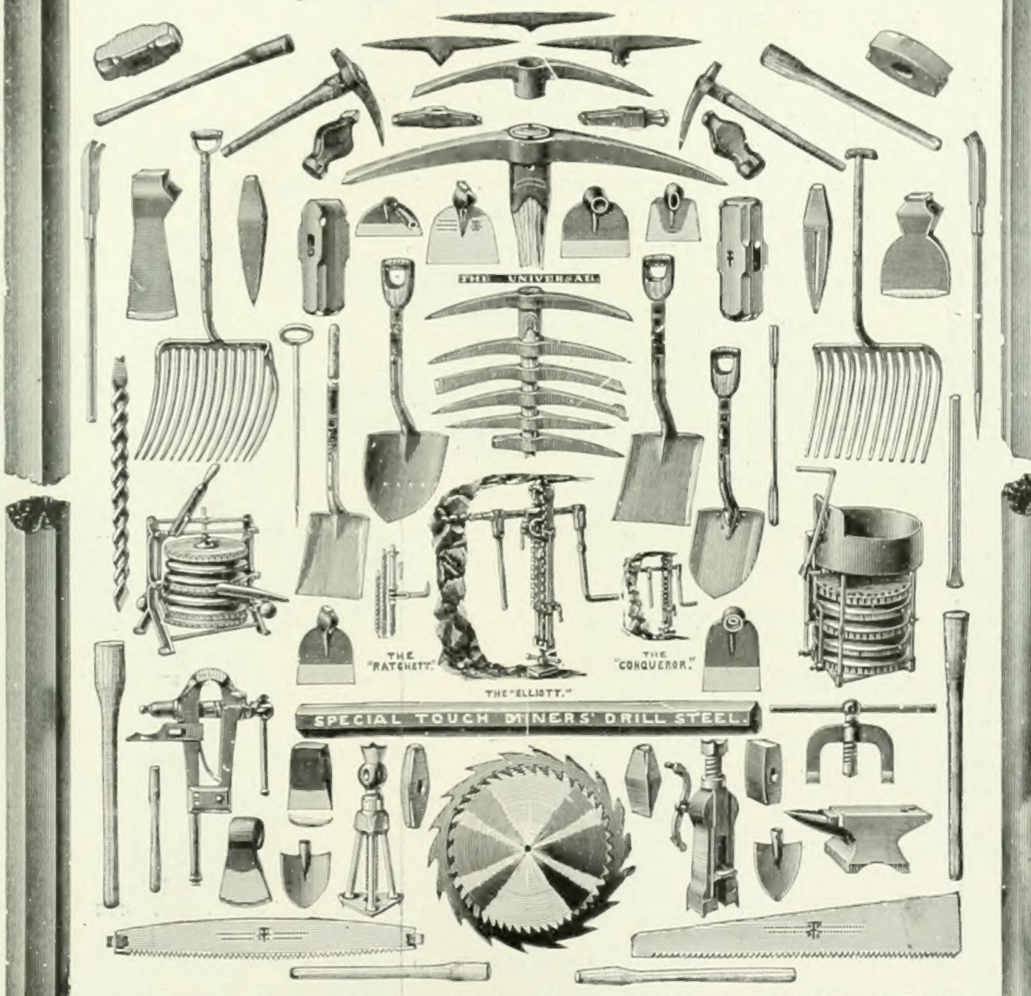
Works: Manchester, Trafford Park.

THE HARDY PATENT PICK CO., LTD., SHEFFIELD, ENGLAND.

Telegraphic Address: "HARDYPICK, SHEFFIELD."

Telephone: National 157. do. Local 157.

High-Class Tools for Miners, Contractors, Quarrymen & Agriculturalists.



Makers of the "Universal" and "Acme" Mining and Navvy Picks.
HAND & POWER BORING MACHINES FOR ROCK & COAL.
Picks, Shovels, Spades, Forks, Hoes, Axes, Hammers, Wedges, Crowbars,
and all Mining, Quarry, Contractors, and Agricultural Tools.

SPECIAL TOUGH DRILL STEEL, SHEAR, CAST, & BLISTER STEEL, SAWS, FILES & RASPS.
IMPORTERS OF HICKORY HANDLES.

For contents of the Magazine for the month, see pages 2 and 4. Index to Advertisers, pages 41, 43, 44, and 46.

The whole of the contents of this publication are copyright, and full rights are reserved.

CONTENTS

No. 5. NOVEMBER, 1903. Vol. III.

(*Continued on Page 4.*)

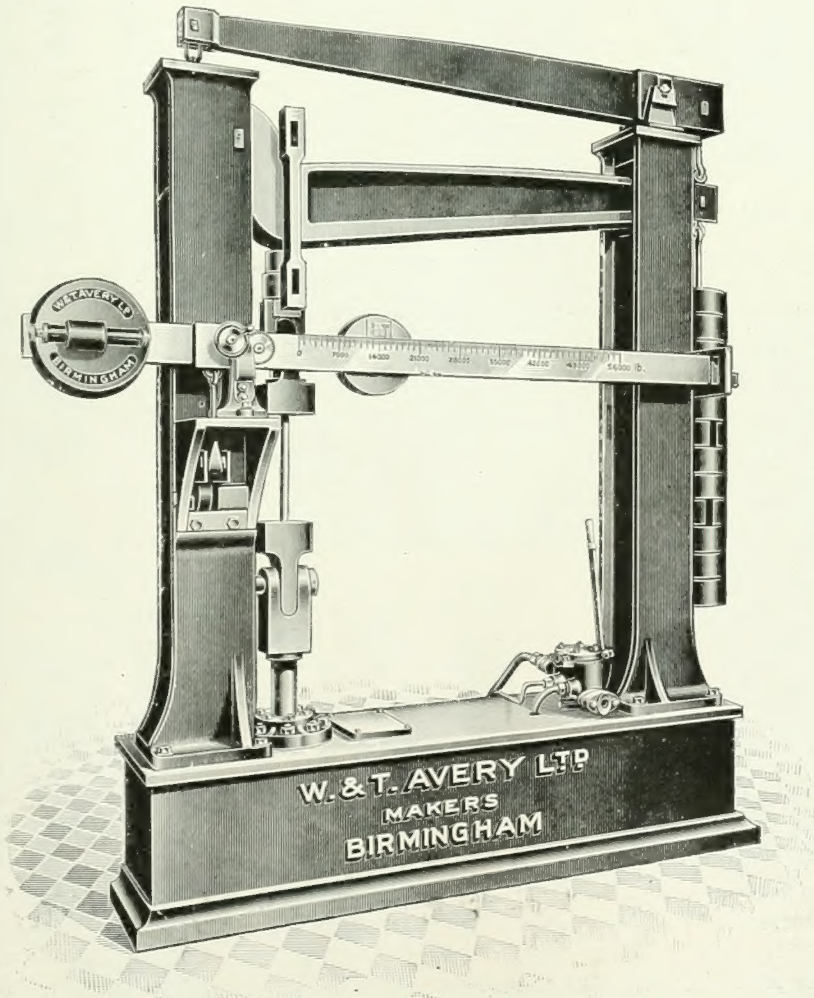
The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

BY ROYAL WARRANT TO H.M. THE KING

W. & T. AVERY LTD.

ESTD 1730
SOHO FOUNDRY
BIRMINGHAM

THE LARGEST MAKERS OF WEIGHBRIDGES IN THE WORLD



AVERY'S TESTING MACHINE

FOR

TENSILE, TRANSVERSE AND COMPRESSIVE TESTS.

Testing Machinery a Speciality.

CONTENTS.

(Continued from Page 2.)

SPECIAL ARTICLES.—*(Continued.)*

PROGRESS OF THE ENGINEERING WORLD.

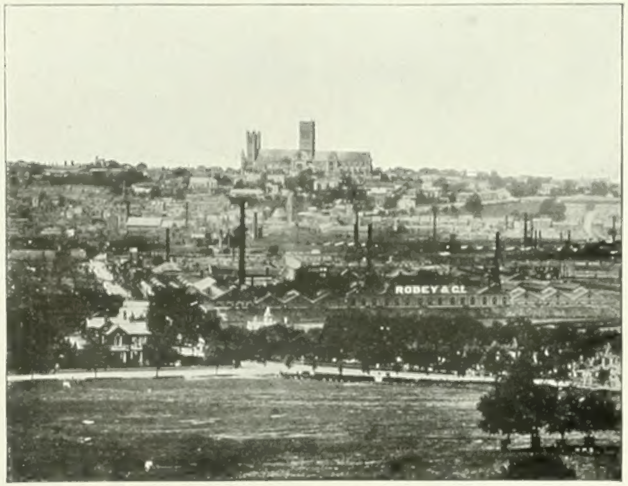
ROBEY & CO., Limited, LINCOLN.

Globe Works,
LINCOLN,
. . . ENGLAND.

LONDON Offices
and Show Rooms—
79, QUEEN VICTORIA STREET, E.C.

BRANCHES & AGENCIES
In all Parts of the World.

Over 250 Gold and other Medals Awarded.



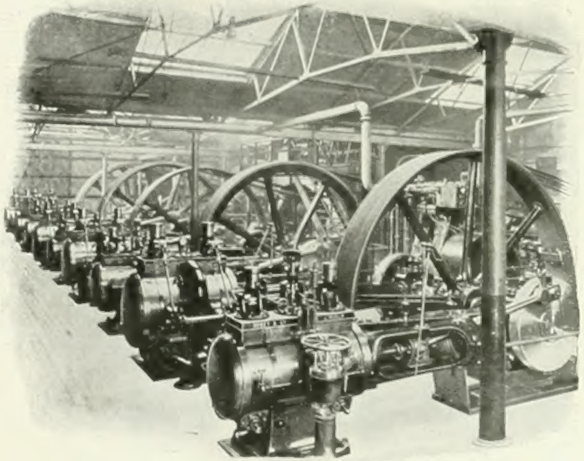
View of the Globe Works, Lincoln.

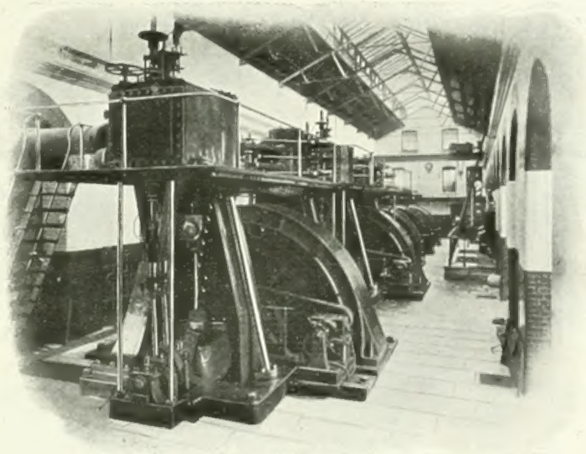
MAKERS OF
STEAM ENGINES
(Simple and Compound)

AND EVERY
DESCRIPTION OF
MINING PLANT.

☞ *Upwards of 22,000 Engines at Work in All Parts of the World.*

Illustrated Catalogues Post Free on Application.


Coupled Compound Horizontal Fixed Engines.


Compound Vertical Engines for Electric Lighting.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron & Steel, Mining, & Allied Industries.

DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

Telephone No.: 3349 GERRARD.
Telegraphic and Cable Address: "SINEWY, LONDON."

ANNOUNCEMENTS.

Subscription Rates per Year.

Great Britain—In advance, 12s. for twelve months, post free. Sample copies, 1s. 4d., post free.

Foreign and Colonial Subscriptions, 16s. for twelve months, post free. Sample Copies, 1s. 6d., post free.

Remittances should be made payable to PAGE'S MAGAZINE, and may be forwarded by Cheque, Money Order, Draft, Post Office Order, or Registered Letter. Cheques should be crossed "LONDON & COUNTY BANK, Covent Garden Branch." P.O.'s and P.O.O.'s to be made payable at East Strand Post Office, London, W.C. When a change of address is notified, both the new and old addresses should be given. All orders must be accompanied by remittance, and no subscription will be continued after expiration, unless by special arrangement. Subscribers are requested to give information of any irregularity in receiving the Magazine.

Advertising Rates.

All inquiries regarding Advertisements should be directed to "THE ADVERTISEMENT MANAGER, Clun House, Surrey Street, Strand, London, W.C."

Copy for Advertisements

should be forwarded on or before the 3rd of each month preceding date of publication.

Editorial.—*All communications intended for publication should be written on one side of the paper only, and addressed to "The Editor."*

Any contributions offered, as likely to interest either home or foreign readers, dealing with the industries covered by the Magazine, should be accompanied by stamped and addressed envelope for the return of the MSS. if rejected. When payment is desired this fact should be stated, and the full name and address of the writer should appear on the MSS.

The copyright of any article appearing is vested in the proprietors of PAGE'S MAGAZINE *in the absence of any written agreement to the contrary.*

Correspondence *is invited from any person upon subjects of interest to the engineering community. In all cases this must be accompanied by full name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

To Machinery Merchants

Send for our New Catalogue of Lathes, Drills, Planes, and other Engineers' Tools. Also for Circular of the Latest New Petroleum Oil Engines (Two Patents, 1902).

BRITANNIA ENGINE AND TOOL FACTORY, COLCHESTER, ENGLAND.

STEAM STOP VALVES.

May we put your name down for a copy of our new Catalogue, Ref. J 22, presently being issued? See our advertisement next month.

ALLEY & MacLELLAN, Limited, POLMADIE, GLASGOW.

Second Edition, Revised. Price 7s. 6d.

DEPRECIATION OF FACTORIES, Mines, and Industrial Undertakings, and their Valuation. With Tables and Examples.

By EWING MATHESON, M.Inst.C.E.

The Principles which should guide the Writing off for wear and tear, Obsolete plant; Terminable or wasting properties; Effect on Income-tax; Value defined as for Compulsory purchase; Going concern, or dismantled; Rateable value, rental value.

"A successful attempt to systematise existing information and to make it possible to arrive at uniformity and accuracy in making up balance sheets for valuations. The work is unique of its kind."—*The Engineer.*

E. & F. N. SPON, 125, Strand, London.

ELECTRICAL ENGINEER (25), who has just completed training, seeks work and further experience in any branch of electrical industry, either at home or abroad. Good references. Drawing Office, Scientific, Works, and University experience. Speaks French.—Apply, COLLEGIATE, PAGE'S MAGAZINE, Clun House, Surrey Street, London, W.C.

Mr. G. H. HUGHES, A.M.I.Mech.E.,

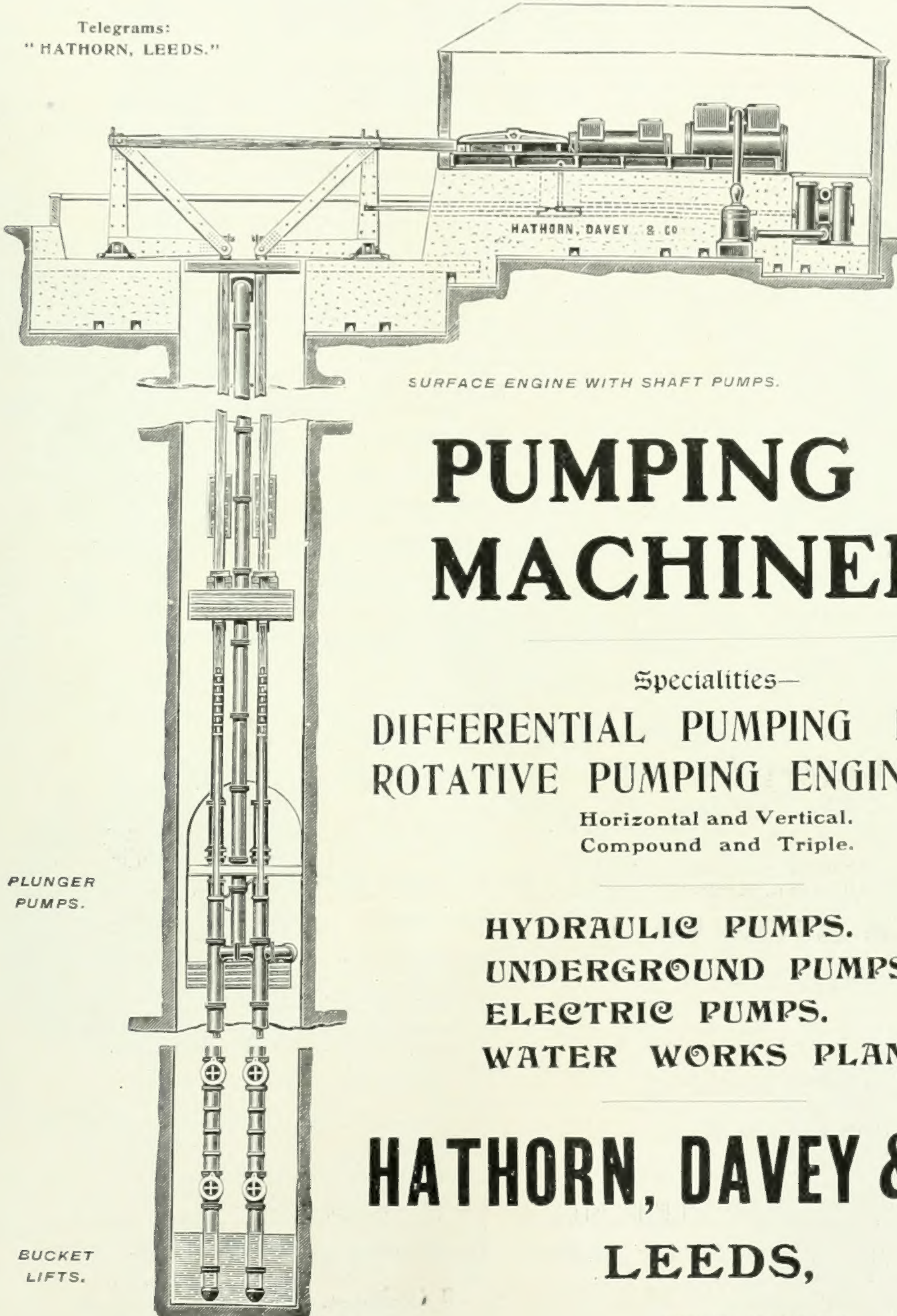
Consulting Engineer for Water Works,

97, QUEEN VICTORIA ST., LONDON, E.C.

Telephone No.: 5754 Bank.

T. HARDING CHURTON & CO., INGRAM STREET, LEEDS.	**DYNAMOS AND MOTORS.**	See Page 75.
JOSEPH BOOTH BROS., LTD., RODLEY, LEEDS.	**LIFTING MACHINERY.**	See Page 78.
THOS. W. WARD, ALBION WORKS, SHEFFIELD.	**MACHINE TOOLS.**	See Page 19.
THE SHANNON, LTD., Ropemaker St., London, E.C.	**OFFICE APPLIANCES.**	See Page 90.

Telegrams:
"HATHORN, LEEDS."



SURFACE ENGINE WITH SHAFT PUMPS.

PUMPING MACHINERY

Specialities—

DIFFERENTIAL PUMPING ENGINES.
ROTATIVE PUMPING ENGINES.

Horizontal and Vertical.
Compound and Triple.

HYDRAULIC PUMPS.
UNDERGROUND PUMPS.
ELECTRIC PUMPS.
WATER WORKS PLANT.

HATHORN, DAVEY & CO., LIMITED,

LEEDS,

ENGLAND.

BUYERS' DIRECTORY.

NOTE.—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index to Advertisers on pages 41, 43, 44, & 46.

In order to assure fair treatment to advertisers, each firm is indexed under its leading speciality ONLY.

Advertisers who prefer, however, to be entered under two or more different sections can do so by an annual payment of 5s. for each additional section.

Belting.
Fleming, Birkby & Goodall, Ltd., West Grove, Halifax.

Boilers.
Clayton, Son & Co., Ltd., Leeds City Boiler Works, Leeds.
Galloways, Ltd., Manchester.
John Thompson, Wolverhampton.

Boilers (Water-tube).
Babcock & Wilcox, Ltd., Oriel House, Farringdon Street, London, E.C.
Cochran & Co. (Annan), Ltd., Annan, Scotland.
B. R. Rowland & Co., Ltd., Climax Works, Reddish, Manchester.
Stirling Co. of U.S.A., 53, Deansgate Arcade, Manchester.

Bolts, Nuts, Rivets, etc.
Richard Davies & Sons, Bilberry Street, Manchester.
Herbert W. Periam, Ltd., Floodgate Street Works, Birmingham.

Books.
E. & F. N. Spon, 125, Strand, London, W.C.

Brass Engine and Boiler Fittings.
Hunt & Mitton, Crown Brass Works, Oozells Street North, Birmingham.

Bridges.
Cleveland Bridge and Engineering Co., Ltd., Darlington, England.

Buildings.
Portable Building Co., Ltd., Fleetwood.

Cables.
St. Helen's Cable Co., Ltd., Warrington, Lancashire.
Suddeutsche Kabelwerke A.-G., Mannheim, Germany.

Carborundum.
Polishers Supply Co., 27, Chancery Lane, London, W.C.

Cement.
J. H. Sankey & Son, Essex Wharf, Canning Town, London, E.

Clutches (Friction).
David Bridge & Co., Castleton Ironworks, Rochdale, Lancashire

Condensing Plant.
Mirrlees-Watson & Co., Ltd., Glasgow.
Wheeler Condenser and Engineering Co., 179, Queen Victoria Street, London, E.C.

Consulting Engineers.
G. H. Hughes, A.M.I.M.E., 97, Queen Victoria Street, London, E.C.

Continental Railway Arrangements.
South Eastern & Chatham Railway Co.

Conveying and Elevating Machinery.
Adolf Bleichert & Co., Leipzig-Gohlis, Germany.
Brown Hoisting Machinery Co., 39, Victoria Street, London, S.W.
Bullivant & Co., Ltd., 72, Mark Lane, London, E.C.
Fraser & Chalmers, Ltd., 43, Threadneedle Street, London, E.C.
Graham, Morton & Co., Ltd., Black Bull St., Leeds, England.
Ropeways Syndicate, Ltd., 30, St. Mary Axe, London, E.C.

Cranes, Travellers, Winches, etc.
Joseph Booth & Bros. Ltd, Rodley, Leeds.
Thomas Broadbent & Sons, Ltd., Huddersfield.

Cranks.
Clarke's Crank & Forge Co., Ltd., Lincoln, England.
Woodhouse & Rixson, Sheffield.

Destructors.
Horsfall Destructor Co., Ltd., Lord Street Works, Whitehall Road, Leeds.

Dredges and Excavators.
Lobnitz & Co., Ltd., Renfrew.
Rose, Downs & Thompson, Ltd., Old Foundry, Hull.

Economisers.
E. Green & Son, Ltd., Manchester.

Ejectors (Pneumatic).
Hughes & Lancaster, 47, Victoria Street, London, S.W.

Electrical Apparatus.
Allgemeine Elektricitäts Gesellschaft, Berlin, Germany.
Brush Electrical Engineering Co., Ltd., Victoria Works, Belvedere Road, London, S.E.
British Westinghouse Electric & Manufacturing Co., Ltd., Norfolk Street, Strand, London, W.C.
Crompton & Co., Ltd., Arc Works, Chelmsford.
Greenwood & Batley, Ltd., Albion Works, Leeds.
T. Harding Churton & Co., Ingram Street, Leeds.
The India Rubber, Gutta Percha, and Telegraph Works Co., Ltd., Silvertown, London, E.
International Electrical Engineering Co., Clun House, Surrey Street, London, W.C.
Mather & Platt, Ltd., Salford Iron Works, Manchester.

Electrical Apparatus (*continued*).
Matthews & Yates, Ltd., Swinton, Manchester.
Newton Brothers, Full Street, Derby.
Phœnix Dynamo Manufacturing Co., Bradford, Yorks.
Simplex Steel Conduit Co., Ltd., 20, Bucklersbury, London, E.C.
Turner, Atherton & Co., Ltd., Denton, Manchester.

Engines (Electric Lighting).
J. & H. McLaren, Midland Engine Works, Leeds.

Engines (Locomotive).
Hunslet Engine Co., Ltd., Leeds, England.
Hudswell, Clarke & Co., Ltd., Leeds, England.

Engines (Stationary).
Allis-Chalmers Co., 533, Salisbury House, Finsbury Circus, London E.C.
Fraser & Chalmers, Ltd., 43, Threadneedle Street, London, E.C.
E. S. Hindley & Sons, 11, Queen Victoria Street, London, E.C.
Robey & Co., Ltd., Globe Works, Lincoln, England.

Engines (Traction).
Jno. Fowler & Co. (Leeds), Ltd., Steam Plough Works, Leeds.

Engravers.
Jno. Swain & Son, Ltd., 58, Farringdon Street, London, E.C.

Fans, Blowers.
Davidson & Co., Ltd., "Sirocco" Engineering Works, Belfast, Ireland.
James Keith & Blackman Co., Ltd., 27, Farringdon Avenue London. E.C.
Matthews & Yates, Ltd., Swinton, Manchester.
The Standard Engineering Co., Ltd., Leicester.

Feed Water Heaters.
Royles, Ltd., Irlam, near Manchester.

Firewood Machinery.
M. Glover & Co., Patentees and Saw Mill Engineers, Leeds.

Fountain Pens.
Mabie, Todd & Bard, 93, Cheapside, London, E.C.

Forgings (Drop).
J. H. Williams & Co., Brooklyn, New York, U.S.A.

Furnaces.
Deighton's Patent Flue & Tube Company, Vulcan Works, Pepper Road, Leeds.
Leeds Forge Co., Ltd., Leeds.

Gas Producers.
W. F. Mason, Ltd., Engineers, Manchester.

Gears.
William Asquith, Ltd., Highroad Well Works, Halifax.
Buffoline Noiseless Gear Co., Levenshulme, Manchester.
E. Arnold Pochin, Croff Street, Pendleton, Manchester.

Gold Dredging Plant.
Fraser & Chalmers, Ltd., 43, Threadneedle Street, London, E.C.

Gauge Glasses.
J. B. Treasure & Co., Vauxhall Road, Liverpool.

Hammers (Steam).
Davis & Primrose, Leith Ironworks, Edinburgh.

Hoisting Machinery.
See Conveying Machinery.

Horizontal Boring Machines.
William Asquith, Ltd., Highroad Well Works, Halifax.

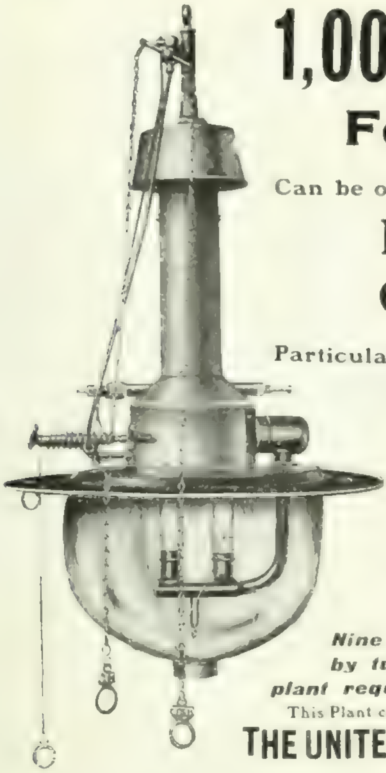
Indicators.
Dobbie McInnes, Ltd., 41 & 42, Clyde Place, Glasgow.

Injectors.
W. H. Willcox & Co., Ltd., 23, 34, & 36, Southwark Street, London.

Iron and Steel.
Askham Bros. & Wilson, Ltd., Sheffield.
Brown, Bayley's Steel Works, Ltd., Sheffield.
Consett Iron Co., Ltd., Consett, Durham, and Newcastle-on-Tyne.
Farnley Iron Co., Ltd., Leeds England.
Fried. Krupp, Grusonwerk, Magdeburg-Buckau, Germany
Hadfield's Steel Foundry Co., Ltd., Sheffield.
J. Frederick Melling, 14, Park Row, Leeds, England.
Parker Foundry Co., Derby.
Walter Scott, Ltd., Leeds Steel Works, Leeds, England.

Laundry Machinery.
W. Summerscales & Sons, Ltd., Engineers, Phœnix Foundry, Keighley, England.

Lighting Apparatus.
United Kingdom Lighting Trust, Ltd., 99, Cannon Street, London, E.C.



1,000 CANDLE POWER

For Id. per Hour,

Can be obtained by using the

KITSON SYSTEM of OIL GAS LIGHTING.

Particularly adapted for Engineering Works. Foundries, Dye Works, and all Large Shops.

WORKING COST of NINE 1,000 Candle power LAMPS given by the North Eastern Marine Engineering Co., Ltd., of Sunderland, after a four weeks' trial from Sept. 1st to Sept. 28th inclusive, at [illegible], or 4/5ths of a penny per lamp.

Nine Lamps connected to the Reservoir by tubing [illegible]-inch in diameter is the whole plant required to produce 9,000 candle power.

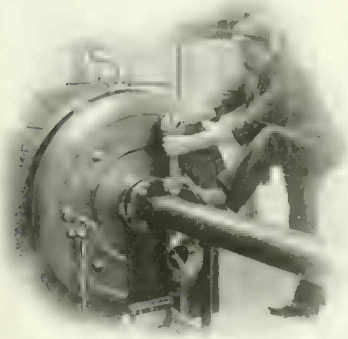
This Plant can be erected within One Month from Date of Order.

THE UNITED KINGDOM LIGHTING TRUST, LTD.

Offices:

99, CANNON STREET, LONDON, E.C.

Finger-Tight *v.* Spanner-Screwed?



GEO. A. DELL, Chief Engineer, American Ordnance Co., Bridgeport, Conn., says:—

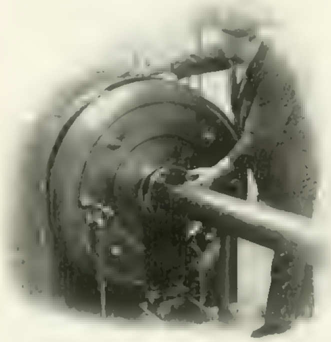
"I have had some very bad fluted rods where I had to use a wrench in order to screw the packing up tight. I have used "P.P.P." on some of the same rods, and by just using my fingers to screw up stuffing boxes, the same were made **tight** and **stayed tight** longer than with any other packing."

If your glands leak, or your hammers "drip" write:

QUAKER CITY RUBBER CO.,
101, LEADENHALL STREET,
LONDON, E.C.

Managers:

RONALD TRIST & CO., The Packing Experts.



These Illustrations are from Photographs taken in a London Works, and show how in the one case, previous to using "Daniel's P.P.P.," it was necessary to be continually screwing up with a spanner, and in the other, how a perfectly steam-tight joint is now made "by just using the fingers."

Lifts.
Waygood & Co., Ltd., Falmouth Road, London, S.E.

Lubricants.
Blumann & Stern, Ltd., Plough Bridge, Deptford, London, S.E.
[illegible] Street, London, E.C.

Lubricators.
Thomas A. Ashton, Ltd., Norfolk Street, Sheffield.
[illegible]
[illegible]

Machine Tools.
George Addy & Co., Waverley Works, Sheffield.
William Asquith, Ltd., Highroad Well Works, Halifax, England.
Hy. Berry & Co., Ltd., Leeds.
Bertram's, Ltd., St. Katherine's Works, Sciennes, Edinburgh.
[illegible]
Britannia Engine and Tool Factory, Colchester England.
C. W. Burton Griffiths and Co., 1, 2, & 3, Ludgate Square, Ludgate Hill, London, E.C.
Chas. Churchill & Co., Ltd., 9-15, Leonard Street, London, E.C.
Luke & Spencer, Ltd., Broadheath, Manchester.
Jos. C. Nicholson Tool Co., City Road Tool Works, Newcastle-on-Tyne.
Northern Engineering Co., 1900, Ltd., King Cross, near Halifax.
J. Parkinson & Son, Canal Ironworks Shipley, Yorkshire.
Pratt & Whitney Co., Hartford, Conn., U.S.A.
Rice & Co. (Leeds), Ltd., Leeds, England.
Wm. Ryder, Ltd., Bolton, Lancs.
Schischkar & Co., Ltd., 65-69, Stafford Street, Birmingham.
G. F. Smith, Ltd., South Parade, Halifax.
Taylor and Challen, Ltd., Derwent Foundry, Constitution Hill, Birmingham.
H. W. Ward & Co., Lionel Street, Birmingham.
T. W. Ward, Albion Works, Sheffield.
West Hydraulic Engineering Co., 23, College Hill, London, E.C.
Charles Winn & Co., St. Thomas Works, Birmingham.

Metals.
Magnolia Anti-Friction Metal Co., Ltd., of Great Britain, 49, Queen Victoria Street, London, E.C.
Phosphor Bronze Co., Ltd., Southwark, London, S.E.

Mircoscopes.
W. Watson & Sons, 313, High Holborn, London, W.C.

Mining Machinery.
Chester, Edward, & Co., Ltd.
Fraser & Chalmers, Ltd., 43, Threadneedle Street, London, E.C.
Hardy Patent Pick Co., Ltd., Sheffield.
Humbolt Engineering Co., Kalk, Nr. Cologne, Germany.
Ernest Scott & Mountain, Ltd., Electrical and General Engineers, Newcastle-on-Tyne, England.
Wilfley Ore Concentrator Syndicate, Ltd., 7-11, Moorgate Street, London, E.C.

Office Appliances.
Globe-Wernicke Co., Ltd., 44, Holborn Viaduct, London, E.C.
Library Bureau, Ltd., 10, Bloomsbury Street, London, W.C.
Library Supply Co., Bridge House, 181, Queen Victoria Street, London, E.C.
Lyle Co., Ltd., Harrison Street, Gray's Inn Road, London, W.C.
Partridge & Cooper, Ltd., 191-192 Fleet Street, London, E.C.
Rockwell-Wabash Co., Ltd., 69, Milton Street, London, E.C.
Shannon, Ltd., Ropemaker Street, London, E.C.
The Trading and Manufacturing Co., Ltd., Temple Bar House, Fleet Street, London, E.C.

Oil Filters.
Vacuum Oil Co., Ltd., Norfolk Street, London, W.C.

Packing.
Lancaster & Tonge, Ltd., Pendleton, Manchester.
The Quaker City Rubber Co., 101, Leadenhall Street, London, E.C.
United Kingdom Self-Adjusting Anti-Friction Metallic Packing Syndicate, 14, Cook Street, Liverpool.
United States Metallic Packing Co., Ltd., Bradford.
J. Bennett von der Heyde, 6, Brown Street, Manchester.

Paper.
Lepard & Smiths, Ltd., 29, King Street, Covent Garden, London, W.C.

Photo Copying Frames.
J. Halden & Co., Albert Square, Manchester.

Photographic Apparatus.
W. Watson & Sons, 313, High Holborn, London, W.C.

Porcelain.
Gustav Richter, Charlottenburg, near Berlin, Germany.

Presses (Hydraulic).
Edwin Mills & Son, Aspley Ironworks, Huddersfield.

Printing.
Southwood, Smith & Co., Ltd., Plough Court, Fetter Lane, London, E.C.

Publishers.
Anglo-Japanese Gazette 39, Seething Lane, E.C.
[illegible] Brussels, Belgium.
Electroteknisk Tidsskrift Publishing Co., Copenhagen, N. Sweden.
Shipping World, Ltd., Effingham House, Arundel Street, Strand, London, W.C.

Pulleys.
John Jardine, Deering Street, Nottingham.
H. J. H. King & Co., Nailsworth, Glos.

Pumps and Pumping Machinery.
Blake & Knowles Steam Pump Works, Ltd., 179, Queen Victoria Street, London, E.C.
Drum Engineering Co., 27, Charles Street, Bradford.
Fraser & Chalmers, Ltd., 43, Threadneedle Street, London, E.C.
J. P. Hall & Sons, Ltd., Engineers, Peterborough.
Hathorn, Davey & Co., Ltd., Leeds, England.
Pulsometer Engineering Co., Ltd., Nine Elms Ironworks, Reading.
Tangyes, Ltd., Cornwall Works, Birmingham.

Radial Drilling Machines.
William Asquith, Ltd., Highroad Well Works, Halifax.

Rails.
Wm. Firth, Ltd., Leeds.

Railway Wagons.
Metropolitan Amalgamated Railway Carriage & Wagon Co., Ltd. Oldbury, Birmingham, England.
Pressed Steel Car Co., 20, Broad Street House, London, E.C.
W. R. Renshaw & Co., Ltd., Phœnix Works, Stoke-on-Trent.

Riveted Work.
F. A. Keep, Juxon & Co., Forward Works, Barn Street, Birmingham.

Roof Glazing.
Mellowes & Co., Sheffield.

Roofs.
D. Anderson & Son, Ltd., Lagan Felt Works Belfast.

Safes.
Chubb & Sons Lock and Safe Co., Ltd., 128, Queen Victoria Street, London, E.C.

Scientific Instruments.
Cambridge Scientific Instrument Co., Ltd., Cambridge.

Stampings.
Armstrong, Stevens & Son, Whittall Street, Birmingham.
Thos. Smith's Stamping Works, Ltd., Coventry.
Thomas Smith & Son of Saltley, Ltd., Birmingham.

Steam Traps.
British Steam Specialties, Ltd., Fleet Street, Leicester.

Steel Tools.
Saml. Buckley, St. Paul's Square, Birmingham.

Stokers.
Meldrum Brothers, Ltd., Atlantic Works, Manchester.

Stone Breakers.
S. Pegg & Son, Alexander Street, Leicester.

Strong Room Doors.
Chubb & Son's Lock and Safe Co., Ltd., 128, Queen Victoria Street, London, E.C.

Time Recorders.
Howard Bros., 10, St. George's Crescent, Liverpool.
International Time Recording Co., 171, Queen Victoria Street, London, E.C.

Tubes.
Thomas Piggott & Co., Ltd., Spring Hill, Birmingham.
Tubes, Ltd., Birmingham.
Weldless Steel Tube Co., Ltd., Icknield Port Road, Birmingham.

Turbines.
G. Gilkes & Co., Ltd., Kendal.
W. Günther & Sons, Central Works Oldham.
S. Howes, 64, Mark Lane, London, E.C.

Typewriters.
Empire Typewriter Co., 77, Queen Victoria Street, London, E.C.
Oliver Typewriter Co., Ltd., 75, Queen Victoria Street, London, E.C.
Remington Typewriter Co., 100, Gracechurch Street, E.C.
Yost Typewriter Co., 50, Holborn Viaduct, London, E.C.

Valves.
Alley & MacLellan, Ltd., Glasgow.
Scotch and Irish Oxygen Co., Ltd., Rosehill Works, Glasgow.

Ventilating Appliances.
Matthews & Yates, Ltd., Swinton, Manchester.

Vulcanized Fibre.
Mosses & Mitchell, 70 & 71, Chiswell Street, London, E.C.

Wagons—Steam.
Thornycroft Steam Wagon Co., Ltd., Homefield Chiswick, London, W.

Weighing Apparatus.
W. T. Avery & Co., Soho Foundry, Birmingham, England.
Samuel Denison & Son, Hunslet Moor, near Leeds.

Wells Light.
A. C. Wells & Co., 100A, Midland Road, St. Pancras, London, N.W.

Wood Working Machinery.
Kiessling's Machine Co., 46, Rivington Street, London, E.C.
Kirchner & Co., 21-25, Tabernacle Street, London, E.C.

"Woodite."
"Woodite" Company, Mitcham, Surrey.

Yost
LIGHT-RUNNING TYPEWRITER

The . . .

NEW MODEL No. 10

Combines many improvements of the utmost importance to Typewriter users, and all who are contemplating the adoption of the writing machine, extending its use, or replacing old machines with new, should take the opportunity of testing the New Model YOST. Like all previous styles it does incomparably Beautiful Work. It has a very light touch, is an excellent manifolder, and cuts a good stencil. Seven days' trial is permitted, and machines of any make are accepted in part exchange and liberally allowed for.

Despite its improvements, and consequent extra cost of manufacture, the price of the YOST is still £23, less 5 °/o for cash, or list price by monthly instalments.

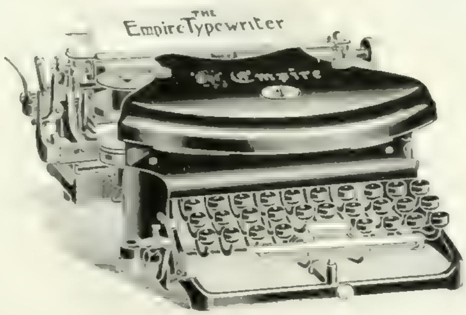
Descriptive Booklet from . . .

The YOST TYPEWRITER Co., Ltd.,
50, HOLBORN VIADUCT, LONDON, E.C.

Save £9 and a lot of worry, and buy an **EMPIRE** TYPEWRITER.

The Machine with ALL the Writing in Sight.

Price £13 2s. 6d. complete.



NOT SURPASSED BY **ANY** MACHINE IRRESPECTIVE OF PRICE.

Contractors to H.M. Government.

The Empire Typewriter Company, Ltd.,
Head Office: 77, QUEEN VICTORIA STREET, LONDON, E.C.

Branches or Agencies:

BIRMINGHAM—43, Temple Street.
BRISTOL—9, John Street.
HANLEY—Post Office Buildings.
LIVERPOOL—7, South John Street.
MANCHESTER—49, Corporation Street.
LEEDS—17, East Parade.
BRADFORD—35, Charles Street.
GLASGOW—87, West George Street.
NOTTINGHAM—48, Parliament Street.
LEICESTER—34, Charles Street.
DUBLIN—Wellington Quay.
And throughout the World.

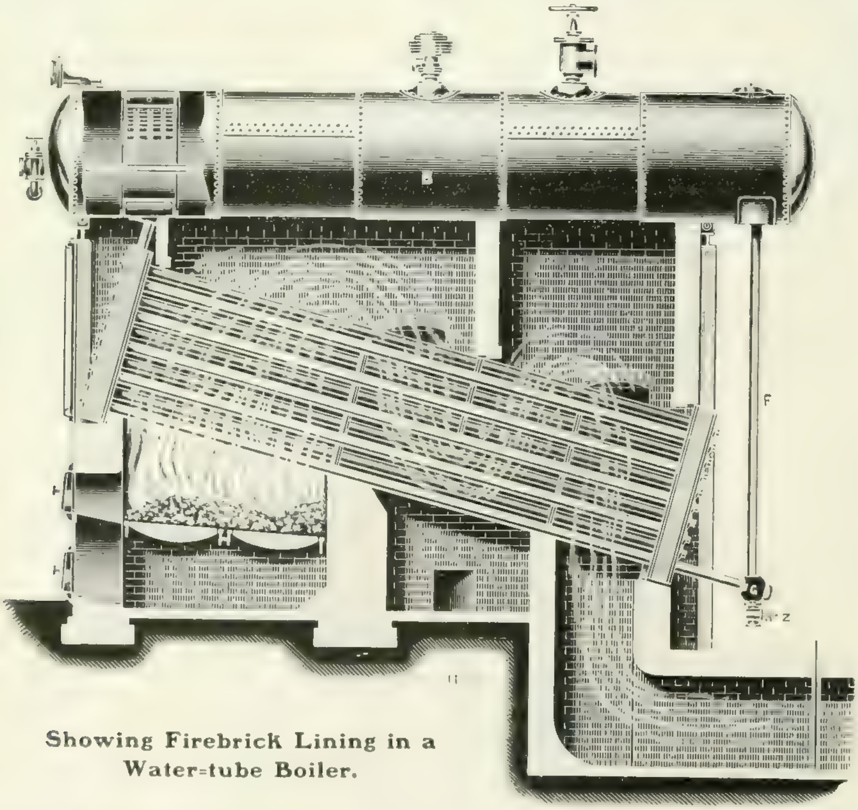
SANKEY'S

ESTABLISHED 1837.

FIRE-RESISTING **BRICKS, CLAYS, and CEMENTS . .**

FOR EVERY DESCRIPTION OF FURNACE WORK.

LARGE & MOST VARIED STOCK. WRITE FOR NEW CATALOGUE.



Showing Firebrick Lining in a Water-tube Boiler.

J. H. SANKEY & SON, Contractors to H.M. Government.

Head Office: ESSEX WHARF, **CANNING TOWN, E.**

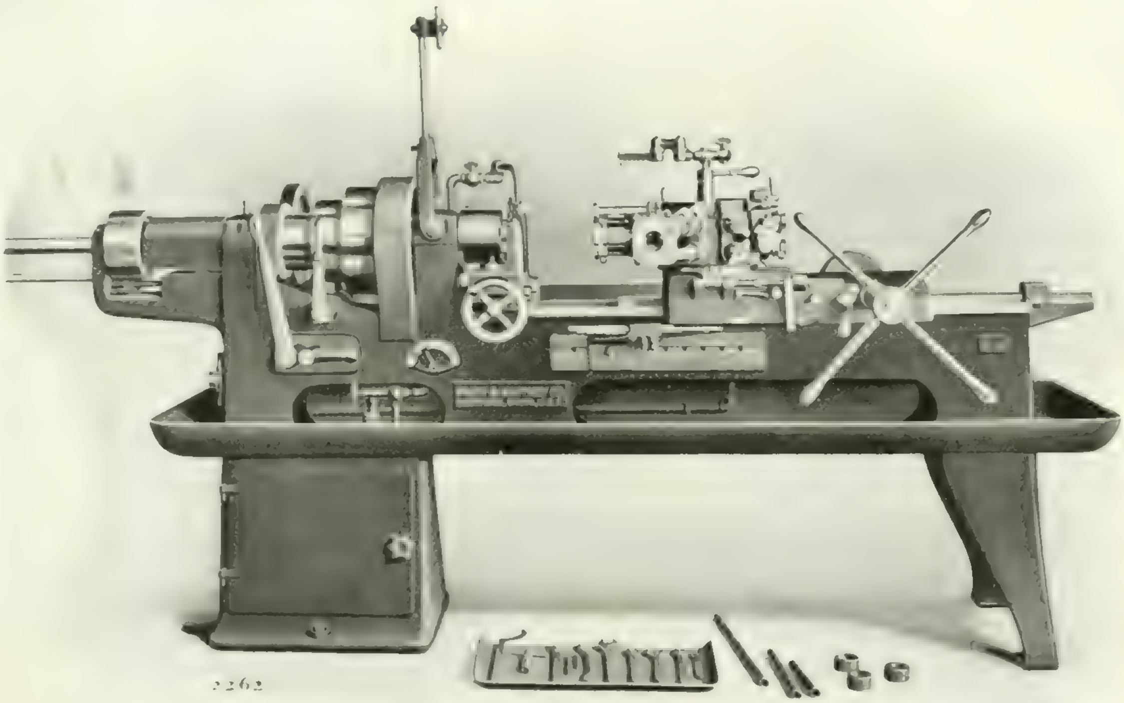
Specialists in Fire-resisting Bricks, &c.

Also Merchants, Shippers, and Exporters of
CEMENT, BRICKS, TILES, SLATES, PIPES, &c.

ESTABLISHED 1837.

NEW MODEL
TURRET LATHES

FIVE SIZES: $\frac{5}{8}$ by $4\frac{1}{2}$ in., 1 by 10 in., $1\frac{1}{2}$ by 18 in., 2 by 26 in., $3\frac{1}{4}$ by 36 in.



2 by 26 in. P. & W. Turret Lathe new model.

THESE MACHINES reach a higher degree of mechanical excellence than has heretofore been attained in turret [illegible]. They are not only adapted to the production of duplicate pieces in large lots, but their use is advantageous for the manufacture of duplicate work in lots of not more than five or six pieces.

IT HAS BEEN DEMONSTRATED that these machines can be set up for given work in less time and with less expense for tools than any other machine of this class.

Send to any of the following Offices for Illustrated Catalogue

PRATT & WHITNEY Co.,

LONDON OFFICES:
BUCK & HICKMAN, Ltd., 2 & 4, Whitechapel Rd., E.
NILES-BEMENT-POND Co., 23-25, Victoria St., S.W.

WORKS: HARTFORD, CONN., U.S.A.

COPENHAGEN, DENMARK: V. LOWENER. STOCKHOLM, SWEDEN: AKTIEBOLAGET V. LOWENER. PARIS: FENWICK FRERES & Co., 21 Rue Martel, Agents for France, Spain, Italy, Belgium, Switzerland, and Portugal.

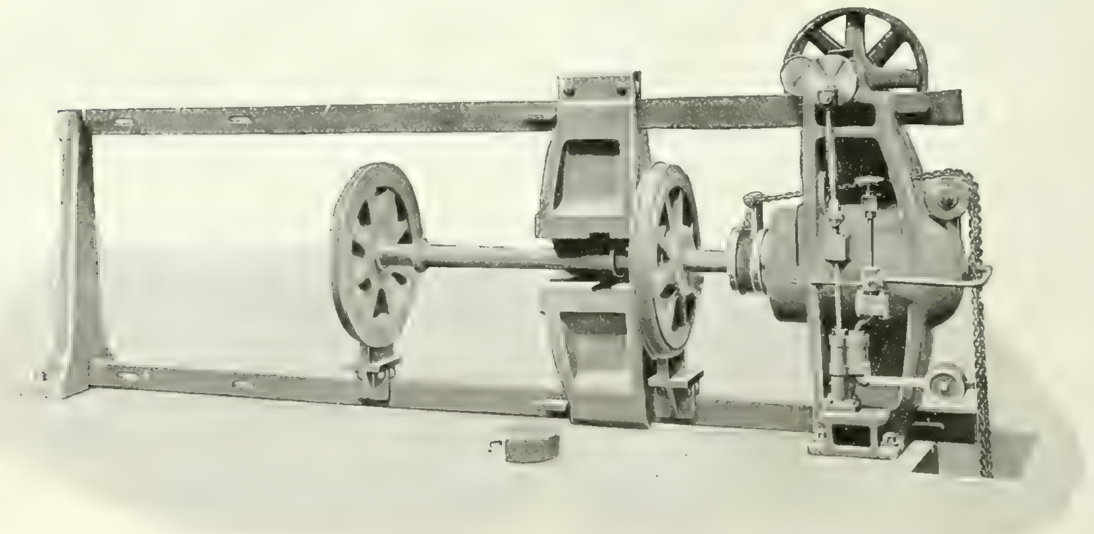
100=TON

Hydraulic Wheel Press

Capable of working up to a total pressure on ram of 135 tons if required.

FOR WHEELS TO 39 INCHES DIAMETER.

Complete with all necessary fittings for putting on one or two wheels at a time, and for forcing off one wheel at a time, with self=contained single plunger pump pressure gauge, valve, &c.

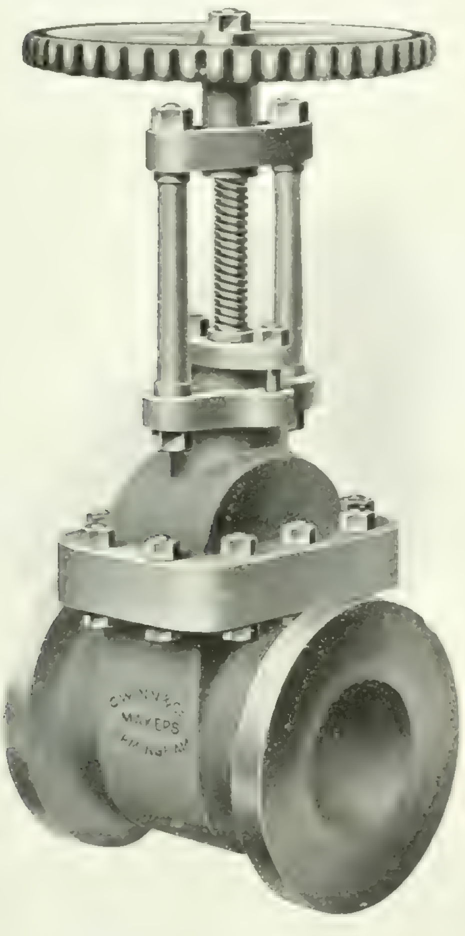


IN STOCK FOR IMMEDIATE DELIVERY.
PRICE AND FULL PARTICULARS SENT ON APPLICATION.

C. W. BURTON GRIFFITHS & Co.

I, 2, & 3, Ludgate Square, London, E.C.,
And at 59, Finnieston Street, GLASGOW.

BOILER & ENGINE FITTINGS



WINN'S

New Catalogue

SECTION D.

Third Edition

NOW READY.

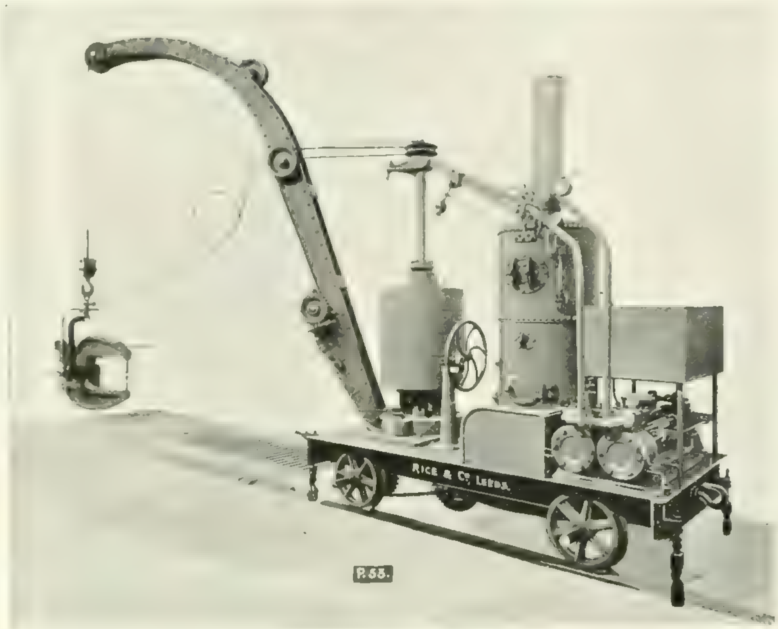
WRITE FOR COPY.

IT WILL
SPEAK
FOR ITSELF.

CHARLES WINN & Co.

Engineers, BIRMINGHAM.

RICE & CO. (Leeds), Ltd.,



PORTABLE RIVETING PLANT

LEEDS,

ENGLAND.

HYDRAULIC

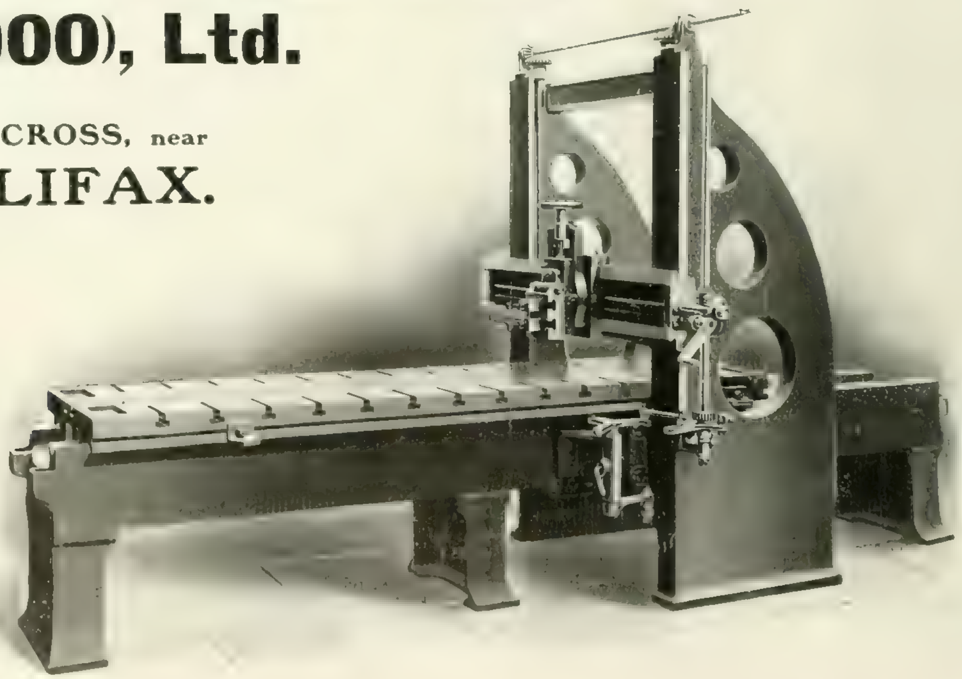
Riveters,	Lifts,
Presses,	Pumps,
Cranes,	Accumulators,
Punches,	Intensifiers,
Shears,	Valves,
Hoists,	&c., &c.

A B C Code, 4th Edition, used.
Telegraphic Address: "Press, Leeds."
Telephone No: 23[illegible]2.

Northern Engineering Co. (1900), Ltd.

KING CROSS, near
HALIFAX.

"PLANING MACHINE, from 2 feet up to 8 feet square."

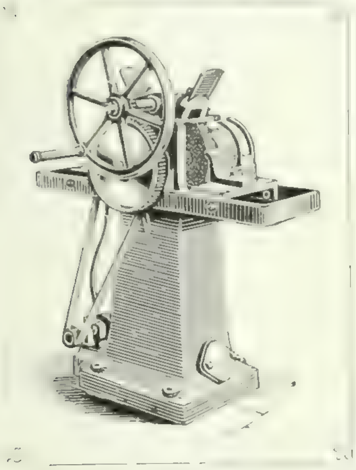


Luke & Spencer, Ltd.,

BROADHEATH,
MANCHESTER.

Telegraphic Address:
"Emery Altrincham
National Telephone
"Altrincham 49

Manufacturers of



GRINDING,
and . . . . .
POLISHING
MACHINES.
EMERY. . .
WHEELS. .
Etc. . . . . .

Send for our Enlarged Catalogue, free on Application.

ACCURATELY MACHINE-CUT **GEARING** WILL PAY YOU IN THE LONG RUN.

CROFF STREET,
PENDLETON,
MANCHESTER.

Write for Price List.

CUNLIFFE & CROOM,

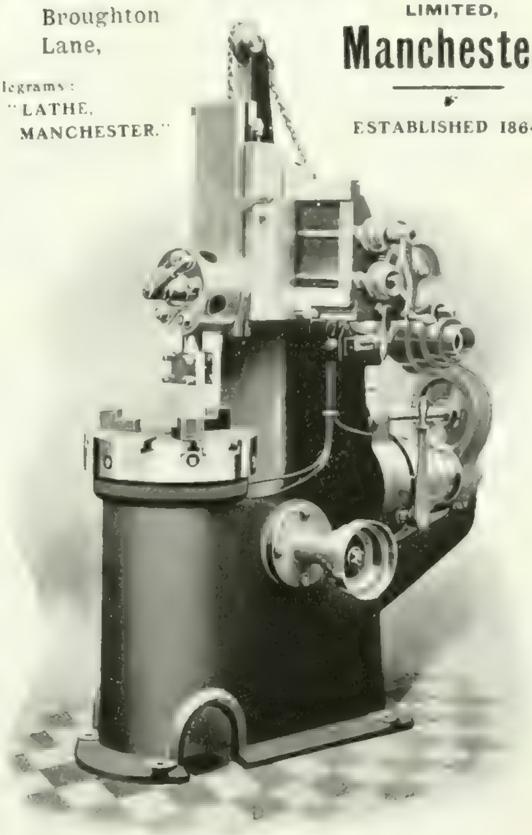
LIMITED,

Broughton Lane,

Manchester.

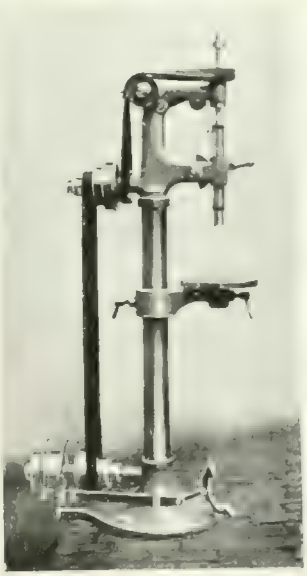
Telegrams:
"LATHE,
MANCHESTER."

ESTABLISHED 1864.



[illegible]

MAKERS OF



Disc Grinders
With Spiral Groove Discs.

Planing Machines
Two-Belt Type, with patent Belt Driving Arrangement.

Vertical Lathes
As Illustrated.

Milling Machines
With rapid return of Table by Rack and Pinion.

CUNLIFFE & CROOM, Ltd.
Broughton Lane,
MANCHESTER.

IMPROVED HIGH-CLASS RADIAL DRILLING, BORING, and TAPPING MACHINES.

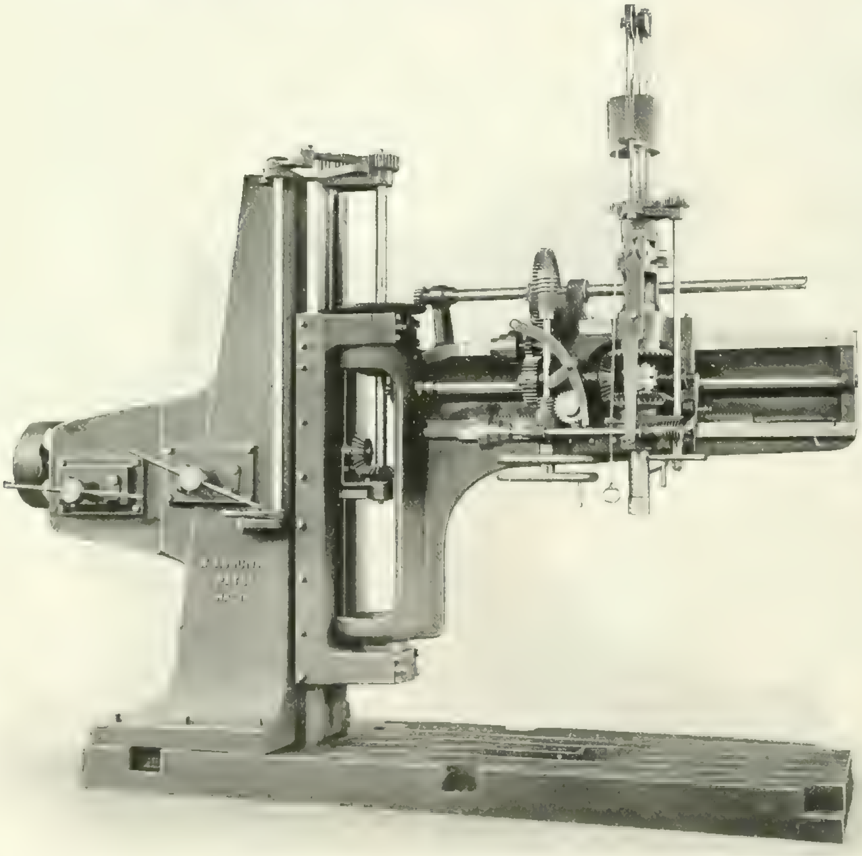
GEAR BOX

giving large number of SPEED CHANGES, quickly obtained by moving levers, without stopping the Machine. . . .

NO CONES:

Thus obviating excessive wear and tear of belts, belt slip, waste of time in speed changing, attending to belt repairs, etc.

16 CHANGES of **CUTTING SPEED** can be obtained in **UNDER 30 SECONDS.**



Machines of the above type made 5ft., 6ft., 7ft., radius. Special line in 3ft. 6in. Radials, GEAR BOX driven.

Our Machines will utilise to full limits the NEW HIGH-SPEED STEELS.

WILLIAM ASQUITH, Ltd., *RADIAL MAKERS,*

ESTABLISHED 1865.

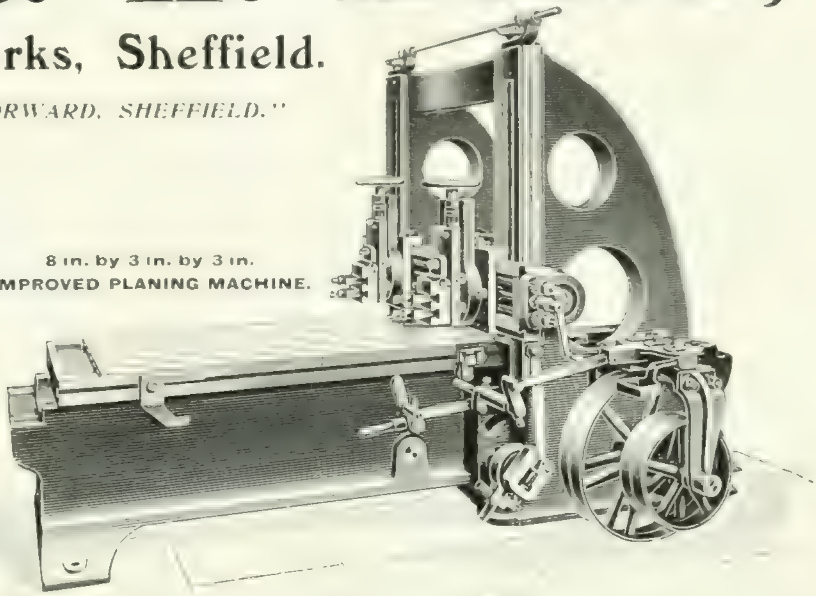
[illegible] H.M. War Department, the [illegible] Imperial [illegible] [illegible] Governments.

HALIFAX, England.

THOS. W. WARD,

Albion Works, Sheffield.

Telegrams - - "FORWARD, SHEFFIELD."



8 in. by 3 in. by 3 in.
IMPROVED PLANING MACHINE.

SEND FOR CATALOGUES
(New Issue) Post Free.

HIGH-CLASS NEW MACHINE TOOLS

IN STOCK FOR IMMEDIATE DELIVERY.

THE

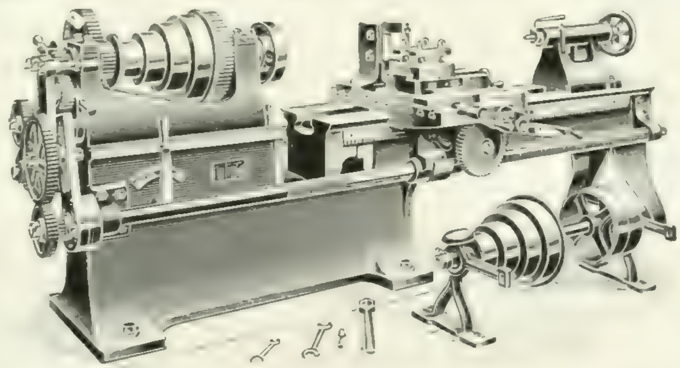
Jos. C. NICHOLSON TOOL Co.

Engineers and Machine Tool Makers,

City Road Tool Works, NEWCASTLE-ON-TYNE.

Telegrams: "MACHINERY."

SPECIALITY FOR **Big Cuts**



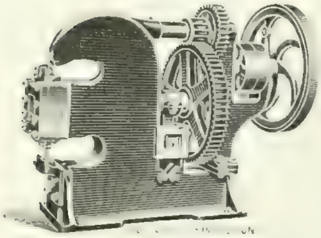
FOR **High Speeds**

THE "COLLINGWOOD" HIGH-CLASS, SCREW-CUTTING LATHES.

Headstock powerfully geared. Tailstock with slide adjustment. Saddle, Heavy. Handle Feed Motion to [illegible] shaft giving three changes of feed, and Gearing machine cut from the solid.

(WRITE FOR OUR NEW POCKET CATALOGUE.)

BERTRAMS LIMITED



Punching, Shearing, and Angle Cutting Machine.

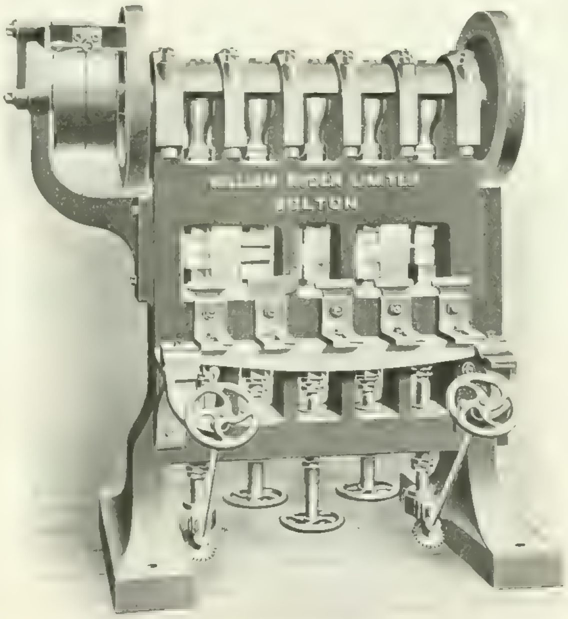
London Office:
21, Gt. St. HELEN'S, E.C.

ST. KATHERINE'S WORKS,
SCIENNES, EDINBURGH.

Manufacturers of all kinds of

MACHINE TOOLS

FOR ENGINEERS, SHIP BUILDERS,
BOILER MAKERS, &c., &c.



FORGING MACHINES,

CAPSTAN LATHES

AND OTHER TOOLS.

SAWING MACHINES.

WILLIAM RYDER, Ltd.
BOLTON.

"THE BOLTON BLACKSMITH."

"IDEAL" SAW GUARDS

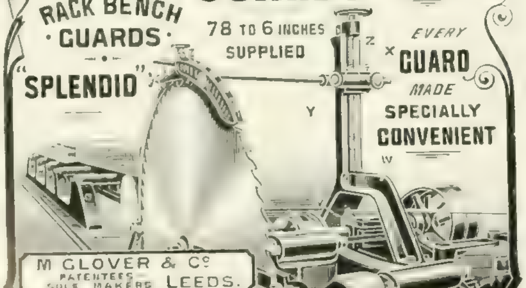
HIGHLY FINISHED BRASS & STEEL

RACK BENCH · GUARDS ·

"SPLENDID"

78 TO 6 INCHES SUPPLIED

EVERY GUARD MADE SPECIALLY CONVENIENT



M GLOVER & Co
PATENTEES — SOLE MAKERS LEEDS.

FIREWOOD MACHINERY

Does the work of from 12 to 80 Men

The saving in wages alone means

A Large - -
Annual Income.

A SPLENDID ADJUNCT OR SEPARATE BUSINESS

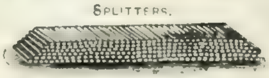
OUR IMPROVED PATENT

Saw Sharpening Machines ARE

Universally Appreciated.

GLOVER'S PATENTS

SPLITTERS.



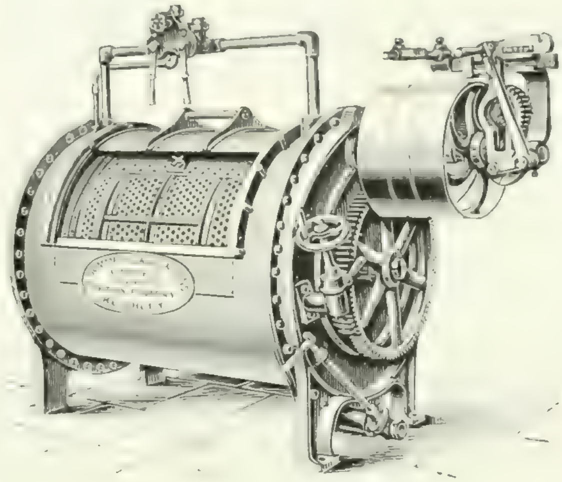
ARRANGERS.

BUNDLERS.

LAUNDRY MACHINERY

Also

COOKING APPARATUS



Catalogues on Application.

W. Summerscales & Sons, Ltd.,

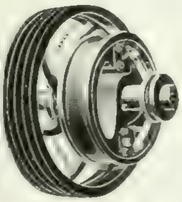
PHOENIX FOUNDRY, KEIGHLEY, ENGLAND.

HEYWOOD & BRIDGE'S

Improved Patent

FRICTION CLUTCH

A Clutch for all Drives.



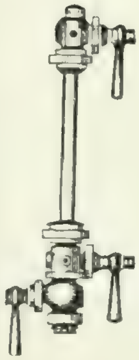
GENERAL DRIVE.

Hundreds of Repeat Orders.
Thousands Working
Complete Clutch Installation our Speciality
New Work, 60 pages, Free.

DAVID BRIDGE & Co.,

Castleton Iron Works, ROCHDALE, LANCS.

London Office, 35, QUEEN VICTORIA STREET, E.C.



J. B. TREASURE & Co.

Excelsior Fire-Polished

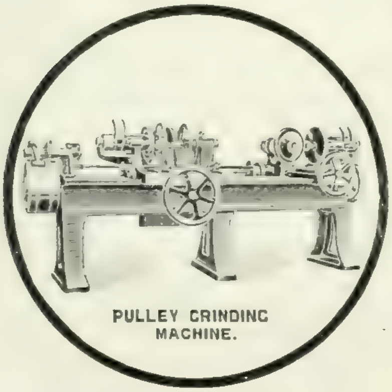
GAUGE GLASSES,

LUBRICATORS,

INDIA-RUBBER WASHERS,

&c., &c.

Vauxhall Road, Liverpool.



PULLEY GRINDING MACHINE.

Machine

Special and General. **Tools.**

A LARGE NUMBER IN STOCK AND PROGRESS.

RADIAL DRILLS

Up to 10 Feet Radius.

G. F. SMITH, Ltd.,

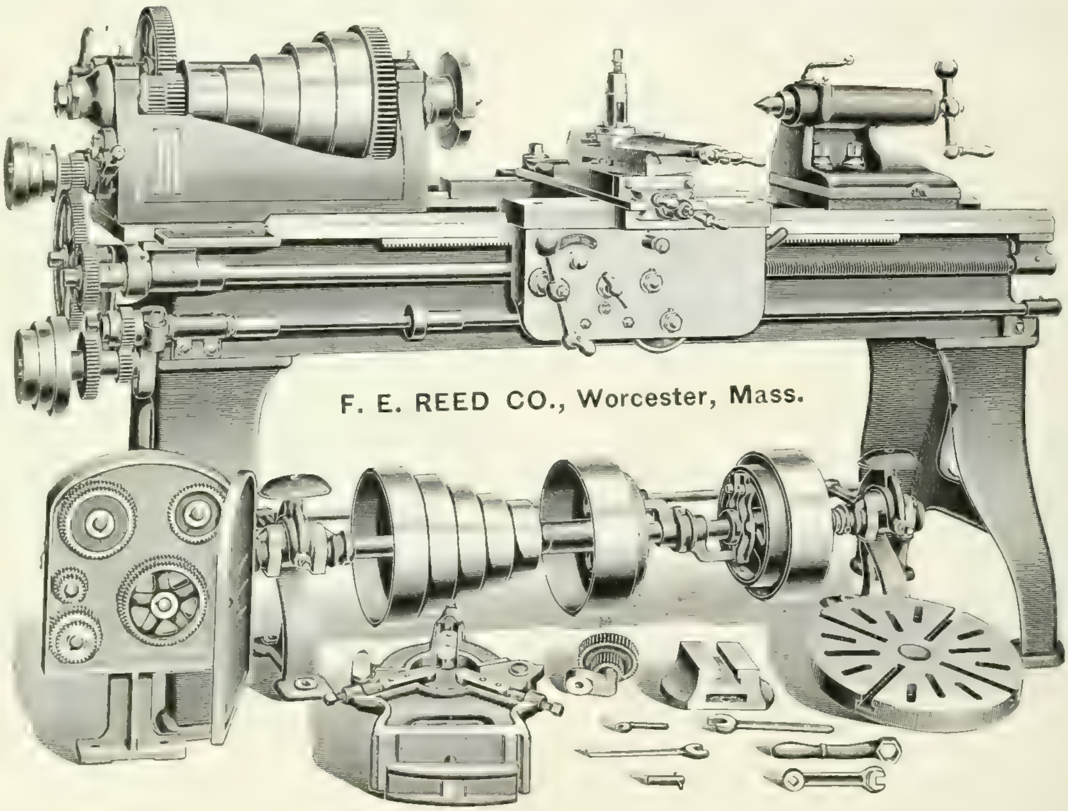
South Parade, HALIFAX.

Telegrams: RADIAL, H[illegible]

CHARLES CHURCHILL & CO., Ltd.

SOLE AGENTS FOR

The "Reed" Lathes.



"REED" LATHE, 7 in. × 6 ft.

We have the following Sizes in Stock:

6 in. × 5 ft., 7 in. × 6 ft., 8 in. × 6 ft., 8 in. × 8 ft.

SEND FOR PRICES AND PARTICULARS.

LONDON: 9 to 15, Leonard St., E.C. BIRMINGHAM: 2 to 10, Albert St.
MANCHESTER: 2, Charlotte St., Mosley St. GLASGOW: 52, Bothwell St.
NEWCASTLE-ON-TYNE: Albion Buildings, St. James' St.

The West Hydraulic Engineering Co.,

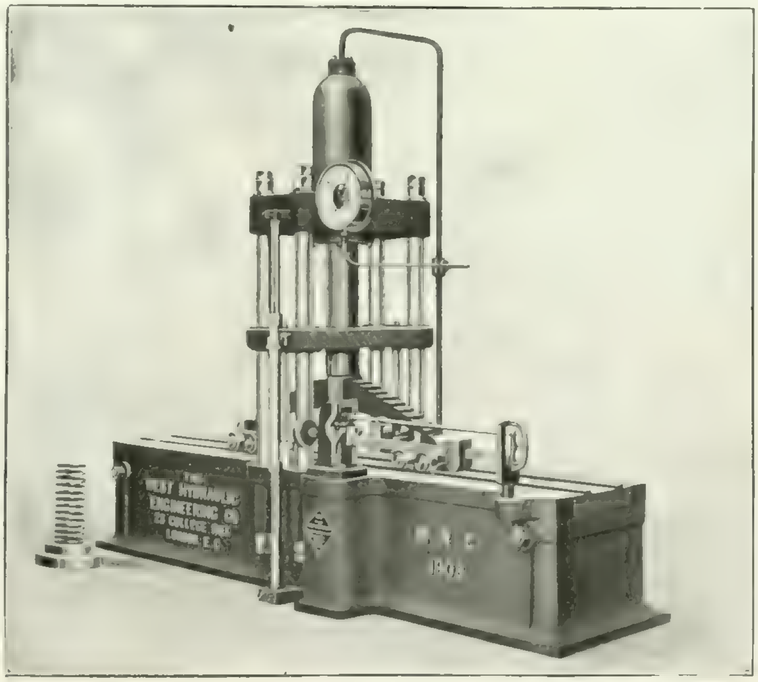
Head Offices : 23, COLLEGE HILL, LONDON, E.C.

Manufacturers of Special High Grade Hydraulic Plant for Arsenals, Explosive and Ordnance Factories, Railways & Engineering Shops.

Contractors to the Governments of

Great Britain,
India,
Germany,
France,
Russia,
Italy,
Spain,
Belgium,
Switzerland,
Japan,
Chili.

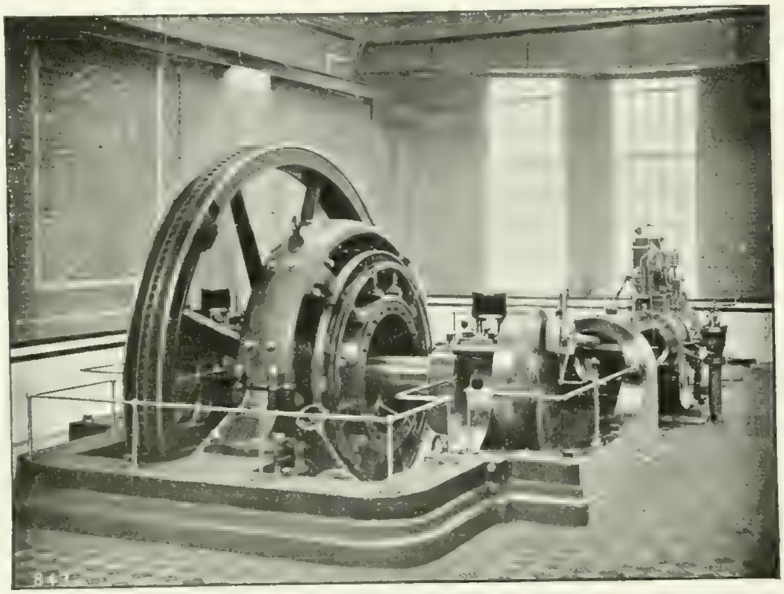
Crown Agents for the Colonies,
&c., &c.



Type M Spring Testing Machine, arranged for testing laminated and volute springs. To work from hydraulic pressure mains or from special test pump.

ERNEST SCOTT & MOUNTAIN, Ltd.

Branch Offices.
LONDON: Norfolk House, Laurence Pountney Lane, E.C.
GLASGOW: 93, Hope Street.
CARDIFF: 8, Working Street.
Sheffield, Birmingham, Calcutta, Bombay, Shanghai, Singapore, Johannesburg.



"Scott and Mountain Class K" Generator. 400 k.w. capacity mounted direct on to Crankshaft of Slow-Speed Compound Engine.

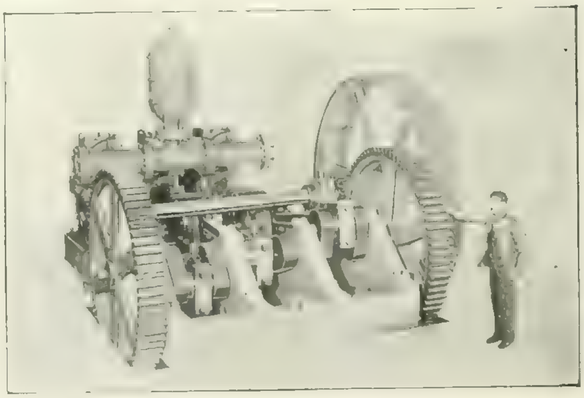
STEAM DYNAMOS.

MOTORS.

Boosters.

Mining Pumps AND Haulage Gears.

Coal Cutters.



"Scott and Mountain" Mining Pump. 300 galls. per min.; 1 500 ft. head.

NEW LISTS NOW READY.

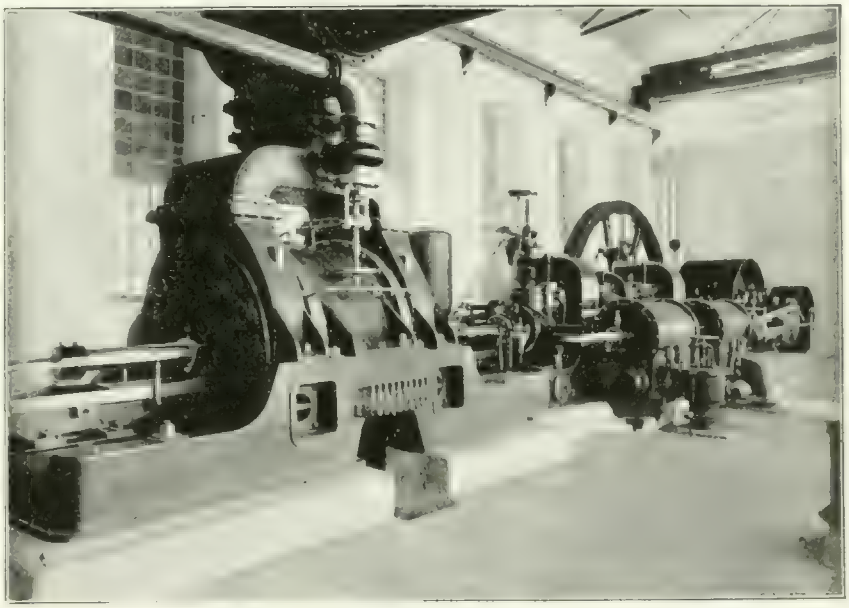
ELECTRICAL AND GENERAL ENGINEERS, NEWCASTLE-ON-TYNE, ENGLAND.

Blast Furnace

GAS ENGINES

(KÖRTING'S PATENT).

TWO CYCLE GAS ENGINES,
RIEDLER BLOWING ENGINES,
RIEDLER AIR COMPRESSORS,
RIEDLER ELECTRIC PUMPS,
RIEDLER EXPRESS PUMPS,
RIEDLER STEAM PUMPS,
CORLISS CORNISH PUMPS,
RAND COMPRESSORS,
WINDING ENGINES,
CORLISS ENGINES,
BOILER PLANTS,
ROASTING, SMELTING, and REFINING MACHINERY.
COMPLETE STAMP MILLS,
CRUSHERS and PULVERIZERS,
CONCENTRATION MACHINERY,
PROSPECTING OUTFITS,
CYANIDE PLANTS,
ELMORE OIL CONCENTRATION PLANTS,
CONDENSING PLANTS,
BOILER FEED PUMPS.
RAND ROCK DRILLS,
ROBINS BELT CONVEYORS,
PELTON WATER WHEELS.



500 H.P. Korting Blast Furnace Gas Engine, with Blowing Cylinder.

Any of the above Catalogues on Application.

Gas Engines from 400 to 3,000 B.H.P.

FRASER & CHALMERS, LTD.

Mining and Engineering Machinery,

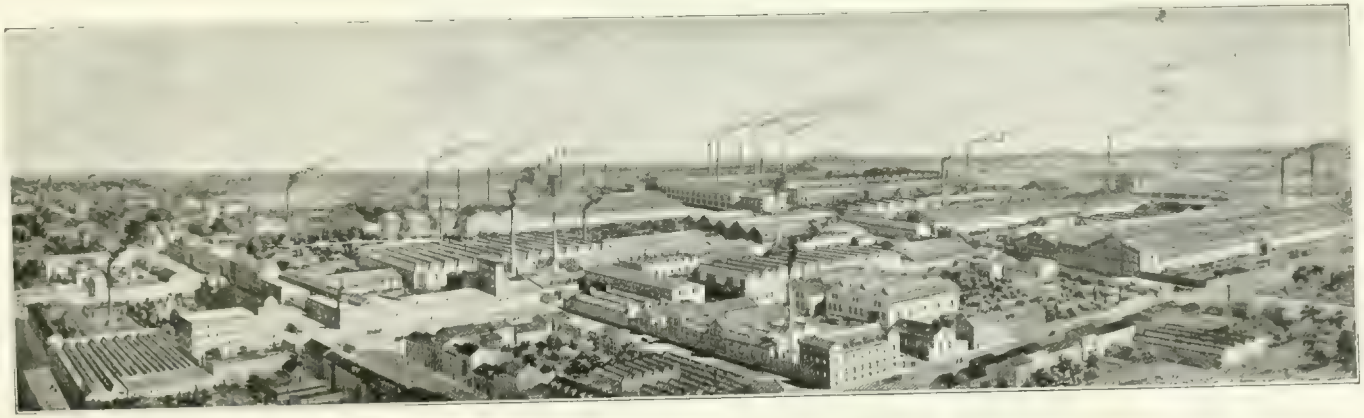
HEAD OFFICE: **3, LONDON WALL BUILDINGS, LONDON, E.C.**

Works: ERITH, KENT, ENGLAND.

THE

HUMBOLT ENGINEERING WORKS Co.,

KALK, near COLOGNE, GERMANY.



VIEW OF THE HUMBOLT WORKS, 1900. FOUNDED IN 1856.

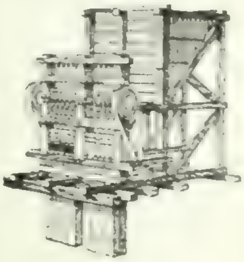
MAKERS OF **MINING, ORE DRESSING, AND COAL WASHING MACHINERY,**

BROWN COAL BRIQUETTE MAKING PLANT.
LOCOMOTIVES, AND STATIONARY BOILERS,
Of Special Construction for burning Brown Coal.

Completely equipped Testing Works at Kalk, for testing bulk samples of Coal and Ore (3-10 tons) before tendering Plants.

Steam Engines, Pumps, & Fans of all kinds.
Reducing Machinery & Complete Plants.
Cement Making Plant.
Linkenbach Slime Tables.
Magnetic Separating Plant (Wetherill system).
Perforated Plates, Coffered Plates.

REPRESENTATIVES IN ENGLAND
H. J. A. HERRMANN, M.I.Min.E., 37, Walbrook, E.C.
W. EDWARD KOCHS & CO., Engineers, High Street, Sheffield.



EDWARD CHESTER & Co., Ltd.

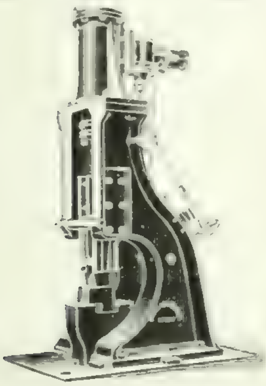
Manufacturers of all Classes of

MINING MACHINERY

Branches: Johannesburg, Bulawayo, Barberton, Port Elizabeth in South Africa, and Kalgoorlie, Australia.

Works: RENFREW, Scotland.

HEAD OFFICE: 120, Bishopsgate Street Within, London, E.C.



STEAM HAMMERS

FOR SMITHS' SHOPS AND FORGES.

Patent Bevelling Machines for Ships' Frames.

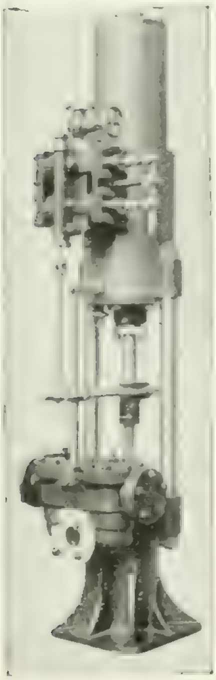
DAVIS & PRIMROSE,

Leith Ironworks, EDINBURGH.

J. P. HALL & SONS, Ltd.,

ENGINEERS,

PETERBOROUGH.



We make a SPECIAL Compound Direct Acting Slow Running

Boiler Feed Pump

ECONOMICAL AND EFFICIENT.

We deliver 100 lbs. of Water for the expenditure of 1 lb. of Steam. This with our 2,000 gallon Pump, and a much higher efficiency as the size of the Pump increases.

AN IDEAL PUMP FOR GENERAL BOILER FEEDING PURPOSES.

Apply for Particulars

FRIED. KRUPP

Aktiengesellschaft

GRUSONWERK.

Magdeburg-Buckau.

Crushing and Mining Machinery.

LARGE TESTING STATION at the WORKS.

CATALOGUES ON APPLICATION.

Sole Representative for Great Britain and Ireland:

W. STAMM, 25, COLLEGE HILL, CANNON ST., LONDON, E.C.

STEEL WIRE ROPES

AND APPLIANCES.

B WIRE ROPES **U** WIRE ROPES **L** WIRE ROPES **L** WIRE ROPES **I** WIRE ROPES **V** WIRE ROPES **A** WIRE ROPES **N** WIRE ROPES **T** WIRE ROPES **S**

FLEXIBLE STEEL WIRE ROPES

FOR

Cranes, Lifts, Hoists, Etc.

ABSOLUTELY RELIABLE.

ONLY ONE UNIFORM QUALITY.

Blocks, Pulleys,

Crab Winches, Tackle, Etc.

MINING & HAULING PLANT.

Illustrated Pamphlets may be obtained on Application.

AERIAL ROPEWAYS

ON ALL SYSTEMS.

ROPEWAY AT PORT ELIZABETH.

Ropeways Constructed to Convey from 50 to 2,000 Tons per Day to Transport all Descriptions of Materials.

Regd. Offices: 72, MARK LANE.

BULLIVANT & CO., Ltd.,

LONDON, ENGLAND.

Works: MILLWALL, E.

ADOLF BLEICHERT & Co., LEIPZIG-GOHLIS, GERMANY

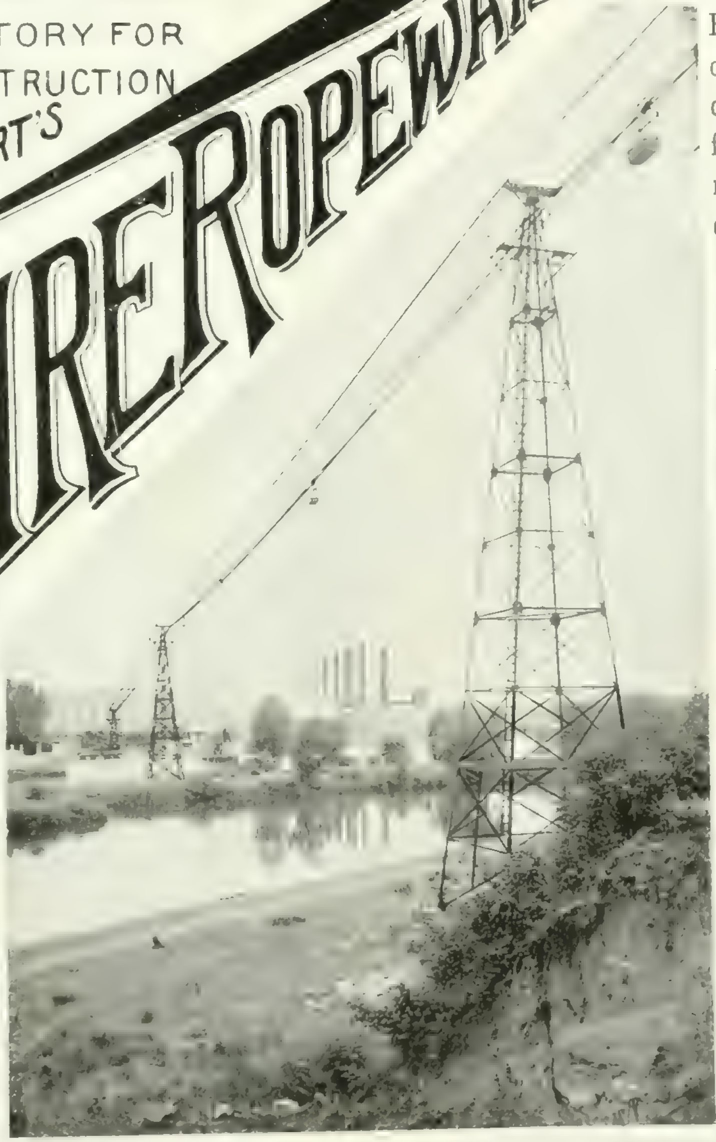
OLDEST AND LARGEST FACTORY FOR THE CONSTRUCTION OF

BLEICHERT'S WIRE ROPEWAYS

Best and cheapest medium of transportation for all kinds of material for any distance and within factories.

All topographical difficulties overcome by our Patent Jaw-Grip Coupling Apparatus.

"Automat."



More than 1,600 Plants were constructed by us, some of a length of 34 kilometres.

30 Years' Experience.

Gold Medals. Highest Awards.

We have built plants with gradients of 1 : 1, and spans of over 1,000 metres.

First-class references from first-rate houses.

Wire-Ropeway executed for Sucreries Centrales de Wanze Soc. Anomyme, Wanze (Belg.)

Special Department for the Construction of

HOISTING & CONVEYING MACHINES, CRANES.

CHEAP TRANSPORT

Improved Aerial Wire Ropeways

(Roe & Bedlington Patents)

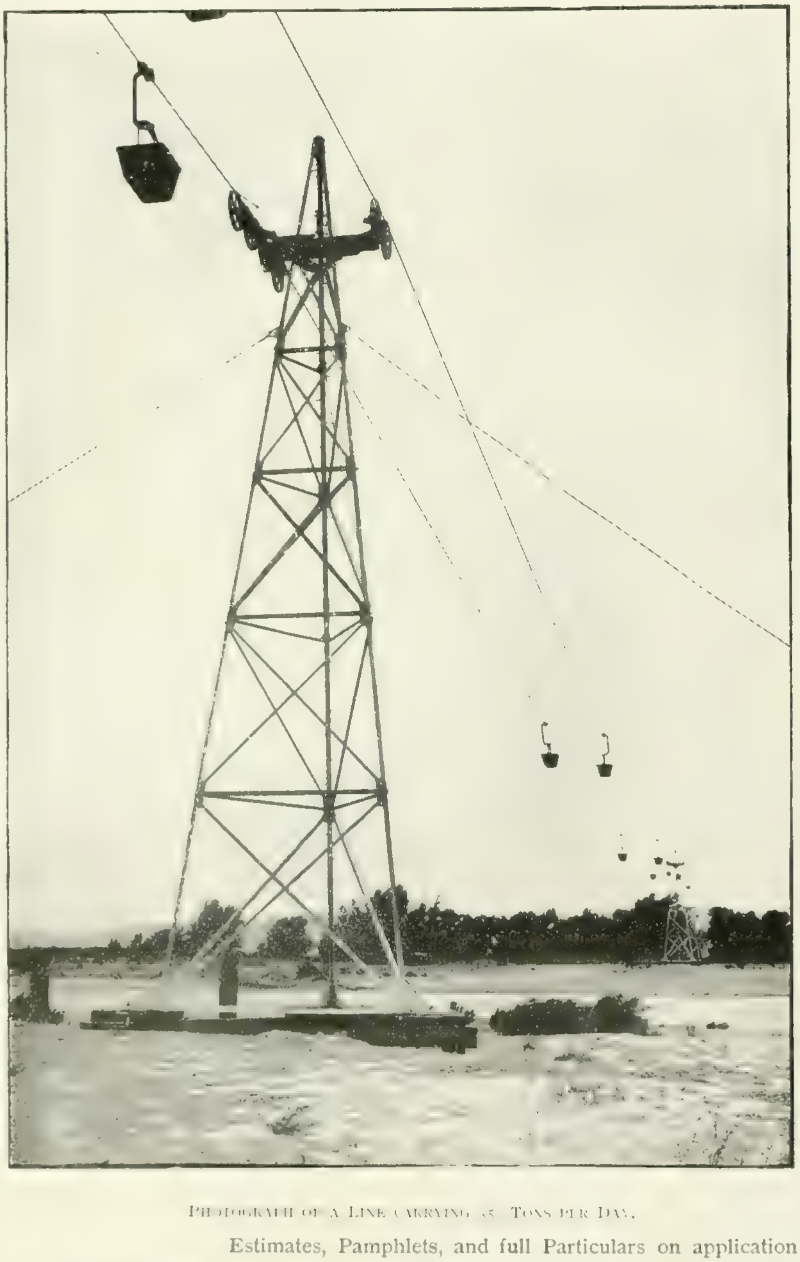
The **Best** and **Cheapest** System for **Carrying Ores, Coals, Limestone, Bricks, Clay**, and other Materials, **Especially over Rough Ground**, and for any distance. **Capacity**, from 20 to 500 tons per day and over.

Advantages

Over Other Systems.

Economy in Cost and Working.
Few Supports.
Reduced Wear of Cables.
Simplicity of Construction.
Long Spans and Steep Gradients Overcome.
High-Class Material.

NUMEROUS INSTALLATIONS AT WORK in England and Abroad, GIVING THE GREATEST SATISFACTION. Inquirers should state LENGTH, CAPACITY, and NATURE OF GROUND.



PHOTOGRAPH OF A LINE CARRYING 35 TONS PER DAY.

Estimates, Pamphlets, and full Particulars on application to

The ROPEWAYS SYNDICATE, Ltd., 30, ST. MARY AXE, E.C.

Telegraphic Address: "ROPEWAYS, LONDON."

THE "Wells Light"

(WALLWORK & WELLS' PATENTS).

POWERFUL PORTABLE LIGHT FROM OIL

Up to 5,000 Candle Power.

For ENGINEERS, CONTRACTORS, SHIPYARDS, RAILWAYS, COLLIERIES, QUARRIES, MINES, HARBOURS, DOCKS, etc.

OVER 17,000 SOLD.

Supplied to 500 British and Foreign Railways.
Adopted by 26 Governments and all leading Firms.
Exclusively used by the Great Military and Naval Powers.

No. 0.	Lamp … Candle-power	Small Hand pattern	£7 7s.
… 1	… Candle-power	Hand pattern	£10 0s.
… 2	1,500 or 2,500 Candles.	Useful and Portable pattern	£15 10s.
… 3	2,500 or 3,500 Candles.	Manchester Ship Canal pattern	£16 10s.
… 4	… Candle	A most powerful Lamp	£17 15s.

… Wells Oil or Petroleum … 30 per cent. more light than petroleum.

KETTLE TORCH LAMPS.

The Miner's Favourite.
Thousands Sold.

Large Flaming Light.

… 4s. 6d. each.

… 9s. each.

No. 18a. A Special Lamp, fitted … 9s. … ge and Drainage Work, …

WELLS' OIL GAS GENERATING LAMPS.

…	11 9
…	13 9
…	14 -
…	17 -
…	16 -
…	19 -

… for above. 2s. each.

WELLS' "LIGHTNING" LIME & COLOR WASHER.

Wallwork & Wells' Patents

NO OUTSIDE POWER REQUIRED.

LIME, WHITING, OR COLD WATER PAINTS,

Applied at a speed of from 8 to 10 square yards per minute, in a manner superior to brush work.

Will save First Cost in a Few Days.

No. 6.	…	£7 7s.
No. 4.	…	£8 10s.
No. 4A	…	£9 10s.
	Same capacity as No. 4 Machine.	
No. 5.	… Can be fitted with Wheels, 25/- extra.	£10 10s.

A. C. WELLS & Co.,
100a, Midland Road, St. Pancras,

Works: Cheetham, Manchester. LONDON, N.W.

THOMAS PIGGOTT & Co., LTD.,

ATLAS WORKS,
SPRING HILL,
BIRMINGHAM.

GAS, HYDRAULIC and GENERAL ENGINEERS.

Gas Plants and Constructional Ironwork of all descriptions.

Columns, Girders, Castings.

Welded and Rivetted Steel Pipes.

Stamped and Steel Angle Flanges.

Steel Chimneys of all sizes and designs.

Tanks in Steel or Cast Iron for Petroleum & Water.

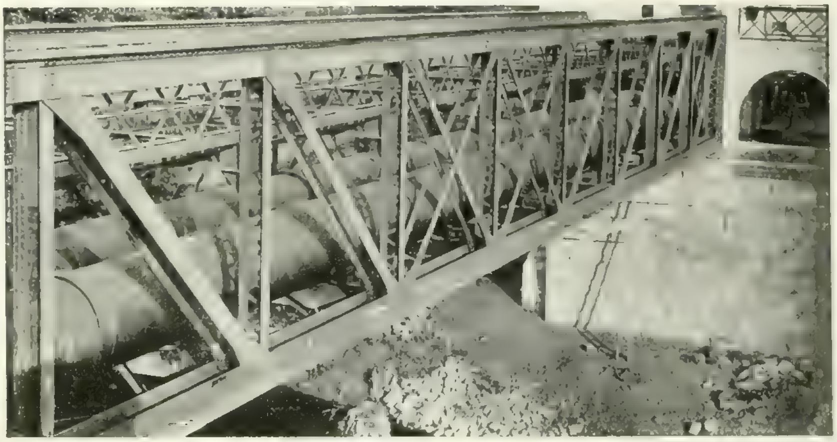
Pans for Sugar, Cassada, &c., for all Markets.

London Office:

14, Ct. St. THOMAS APOSTLE

Telegrams:
"Atlas, Birmingham."
"Intersection, London."

A B C and A1 Codes used.



Steel Lattice Girder Bridge, in one span of 115 feet 10 inches, 12 feet deep, and 13 feet wide, erected over the River Teme at Ludlow, and carrying Welded Steel Main 3 feet 6 inches diameter, for the Birmingham Welsh Water Scheme.

"WOODITE" WORKS, MITCHAM COMMON, SURREY.

NOTICE TO ENGINEERS, ELECTRICIANS, STEAM USERS, and OTHERS. "**WOODITE**" articles can now be obtained with the utmost despatch. "**WOODITE**" has stood the severest test for six years. No material in existence can equal it for Steam or Electrical Purposes and other appliances. Has stood every test up to **40,000** volts for **1/8** in. sheet, without breaking down, by the London Electric Light Corporation and others. Rim "**U**" Hat Joint and Packing Rings, Pump Cups, Gaskets, Manholes, Valves, Sacting, Patent "**WOODITE**" [illegible] Mechanical and other Goods which have hitherto been manufactured in India Rubber, Leather, etc., can now be made of "**WOODITE.**"

"WOODITE" COMPANY, MITCHAM, SURREY.

MANUFACTURERS OF

Weldless Steel

and . . .

Iron Tubes,

Steam Pipes, Hydraulic
Tubes, Boiler Tubes,
High Pressure . .
Steam Mains,

HOLLOW FORGINGS,
COLLARS, FERRULES,
BUSHES, LINERS,
COUPLINGS, AXLES,
PISTON RODS,
Etc., Etc.,
Quoted for on . .
receipt of . . .
particulars.

Tubes

. . FOR . .

Super-heaters

A SPECIALITY.

Contractors to the War Office
and Admiralty.

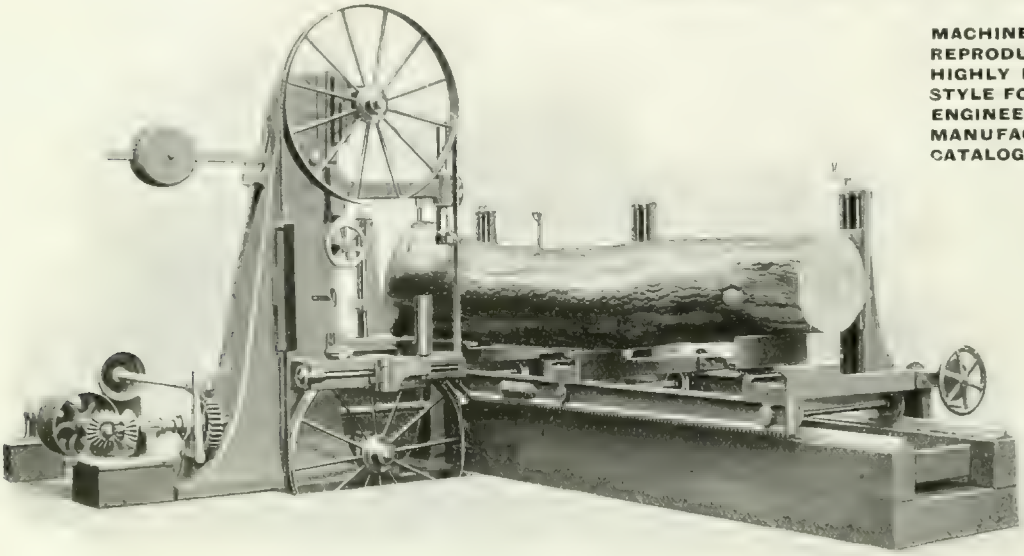
TUBES LIMITED

BIRMINGHAM.

Nat. Telephone No.: 2582. Telegrams: "Cylinders, Birmingham."

JOHN SWAIN & SON, Limited,

PHOTO-ENGRAVERS IN HALF-TONE AND LINE.



MACHINERY REPRODUCED IN HIGHLY FINISHED STYLE FOR ENGINEERS' AND MANUFACTURERS' CATALOGUES.

WOOD ENGRAVERS AND ART REPRODUCERS by all the Latest Methods.

58 FARRINGDON STREET, LONDON, E.C.

Three-Colour Process—a Speciality.

West End Offices : 163a, STRAND, W.C.

It is Worth Your While to Buy Direct

The Reliance Lubricating Oil Co.

Manufacture and Supply the best and Cheapest

HIGH-CLASS NON-CORROSIVE LUBRICATING OILS AND SOLIDIFIED LUBRICANTS.

Castor, Lard, Olive, Neatsfoot, and Linseed Oils, Tallow, &c.

The Reliance Lubricating Oil Co.,

19 & 20, Water Lane, Great Tower Street, LONDON, E.C.

Also 99, Great Clyde Street, Glasgow; and 1, Sandhill, Newcastle-on-Tyne.

Telegrams "[illegible], LONDON"

Telephone No. AVENUE [illegible] ABC Code Used

ESTABLISHED FIFTY YEARS

ENGINEERS

TAYLOR & CHALLEN Ld

CONSTITUTION HILL BIRMINGHAM

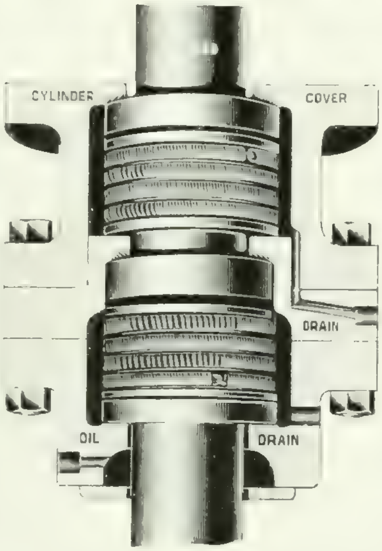
MACHINISTS

PRESSES & DIES / SHEARS LATHES, &c

FOR SHEET METAL WORK

SHAFTING PULLEYS BEARINGS &c

CATALOGUES FREE TO BUYERS



The "LANCASTER" R.T.M.

PATENT . . .

METALLIC PACKING

Supplied to British and Foreign Navies and all Principal Engineers.

CAN BE TIGHTENED UP IN A FEW MINUTES.

WORKING ENGINEERS PREFER THEM TO ALL OTHERS.

Save 60 per cent. of Friction over best Asbestos Packing. Need not the slightest attention.

WRITE FOR FULL PARTICULARS TO—

Lancaster & Tonge, Ltd. Steam Trap, Steam Dryer, & Pistonmakers, Pendleton, MANCHESTER.

THE

Phosphor Bronze Co., Ltd.

Incorporated 1874.

SOUTHWARK, LONDON, S.E.

And at BIRMINGHAM.

"White Ant" Metal

(EQUAL TO BEST MAGNOLIA METAL)

Is the Cheapest and Most Reliable of White Anti-Friction Alloys.

PLASTIC METAL.
("Cog Wheel" Brand)

BABBITTS METAL.
("Vulcan" Brand) Seven Grades

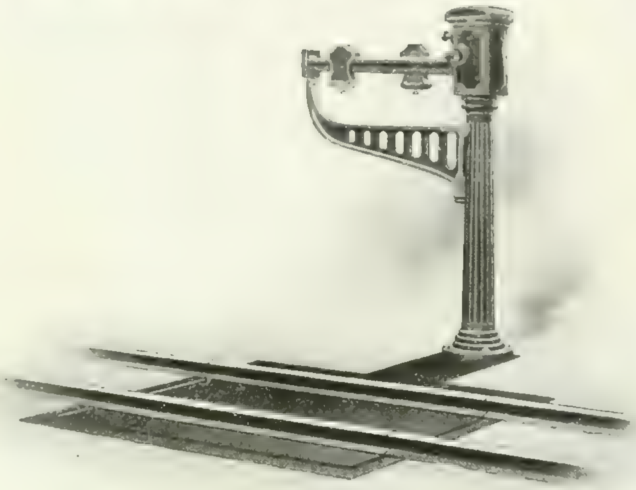
"PHOSPHOR" WHITE LINING METAL.
(Equal to White Brass No. 2.)

"WHITE ANT" BRONZE
(Superior to Fenton's Metal)

See Next Month's Advt. for Phosphor Bronze Alloys.

PHOSPHOR BRONZE,
SILICIUM BRONZE,
"WHITE ANT" METAL,
PLASTIC METAL,
BABBITTS METAL,
Etc

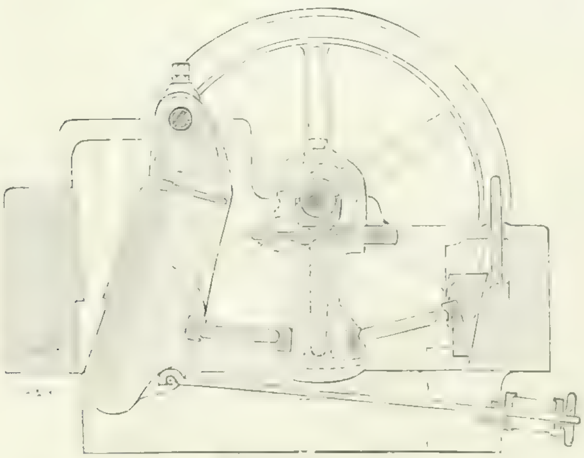
Weigh Everything.



S. DENISON
and SON,
Hunslet Moor,
NEAR LEEDS.

STONE BREAKERS.

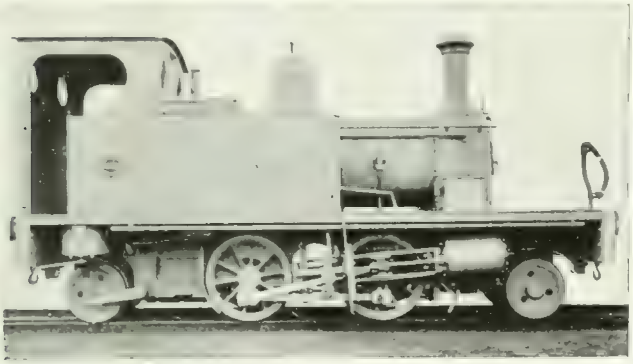
(Improved Blake Type.)



Rollers,
Screens,
Gravel Washers,
Concrete Mixers.

SAMUEL PEGG & SON,
Alexander Street, LEICESTER, ENGLAND.

THE HUNSLET ENGINE CO., LTD.,
LEEDS.

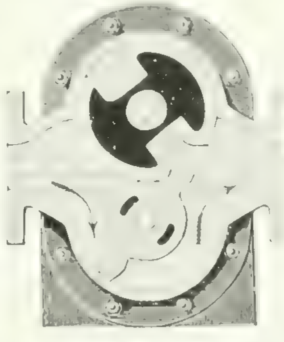


MANUFACTURERS OF

TANK ENGINES Of all Descriptions.

Designs and Specifications Supplied or Worked to.

Telegrams: Engine, Leeds. Telephone: 528



Section of "Drum" Pump.

THE ...

"DRUM" PUMP.

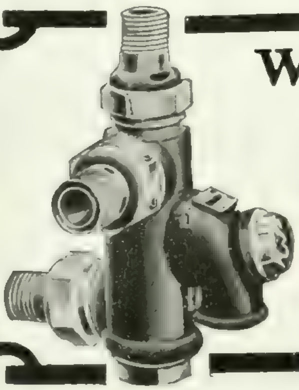
JOHNSON'S PATENTS

POSITIVE ACTION.
NO VALVES.
HIGH EFFICIENCY.

DRUM ENGINEERING CO.,
27, Charles St.,
BRADFORD.

TRIUMPH STOKER

TRIUMPH STOKER Lᴰ.
39, VICTORIA ST., LONDON.



W. H. WILLCOX & Co., Ltd.

23, 34 and 36, Southwark Street, LONDON.

PENBERTHY PATENT INJECTOR

For ALL Boilers. Acknowledged the best for Traction Engines, &c.

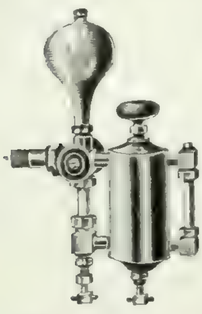
OVER 250,000 IN USE.

HANDLES HOT WATER. Will Deliver at Boiling Point.

Works on High and Low Pressures.

AUTOMATIC and RESTARTING. Lifts up to 22 ft.

IN 3 STYLES AND 16 DIFFERENT SIZES.



Ask for List 36

ASHTON'S SIGHT-FEED LUBRICATORS

NEVER FAIL. Thousands Sold.

— SENT FOR ONE MONTH'S FREE TRIAL. —

Size	¼	½	1	2	4	Pints.
Price	36/-	39/-	45/-	75/-	110/-	each.

Do not confuse this with the cheap, unfinished, American make.

THOMAS A. ASHTON, Ltd., Norfolk Street, Sheffield.

Telegrams: "MILLING, SHEFFIELD."
National Telephone No.: 985.

For the Latest and most Up-to-Date

HEAVY = =
MACHINE
TOOLS = =

PLATE BENDING MACHINE.

Also Special Lifting Jack for Electric Tramcars.

WRITE . . .

GEORGE ADDY & Co.,
WAVERLEY WORKS, SHEFFIELD.

If you want to increase your export business to

DENMARK, NORWAY, & SWEDEN,

ADVERTISE IN

"ELEKTROTEKNISK TIDSSKRIFT"

(STEAM AND ELECTRICITY).

It has a larger sale circulation in these . . countries than any other engineering paper.

M[illegible] Hall, H[illegible] Exp[illegible]
Helsingborg, Sweden.

Specimen copy free on application to

[illegible] issued [illegible] month

THE
Elektroteknisk Tidsskrift
PUBLISHING CO.,
COPENHAGEN, N. DENMARK.

TELEPHONE No: 1400.
TELEGRAMS: "TUTOK, BIRMINGHAM."

Modern . . .
Machine Tools.

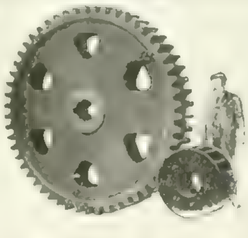
CAPSTAN AND TURRET LATHES.
DRILLING MACHINES.
MILLING MACHINES.
BORING MACHINES.

H. W. WARD & Co.

ONLY ADDRESS

86, Lionel Street,
BIRMINGHAM.

Contractors to British and Foreign Governments and Principal Engineering Firms.



For Gears, Bevels, Worm Wheels, Spirals, or anything in the gear line, write to

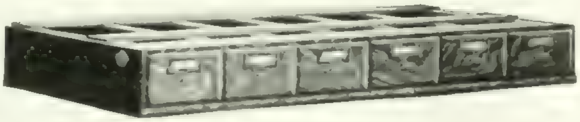
"BUFFOLINE" NOISELESS GEAR Co.,
LEVENSHULME, nr. Manchester,

WHO ARE THE ENGLISH

GEAR SPECIALISTS.

No. 17. Top.

SUITABLE SYSTEMS

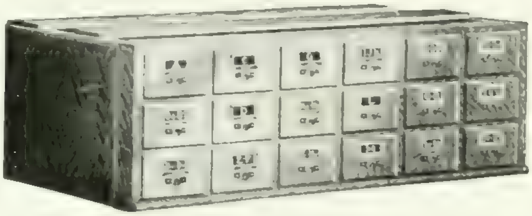


No. 653. Section.

Adapted to the requirements of every modern business, are incorporated in the

Rockwell - Wabash

Business Systems. Every modern and useful device known is at your service. You may **add** or **subtract** at will, yet your Cabinet is complete.



No. 53. Section.

No. 564. Section.

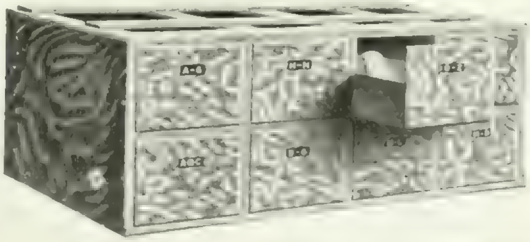
PERPETUAL CARD . . LEDGERS.

VERTICAL FILING SYSTEMS

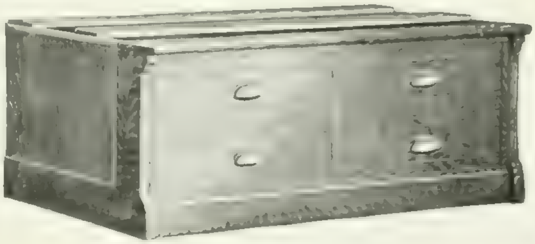
CARD INDEX SYSTEMS

No. 64. Section.

No. 485. Section.



No. 85. Section.



No. 13. Base Section.

Offices and Showrooms:

MANCHESTER:
50, Deansgate Arcade.

NEWCASTLE-ON-TYNE:
24, Collingwood Street.

Registered Offices:

69, MILTON ST.,
LONDON, E.C.

ROCKWELL-WABASH CO., Ltd.,

ELLIOTT D. ROBBINS, Managing Director.

LOBNITZ' GOLD DREDGERS ARE AT WORK IN BRITISH NORTH AND SOUTH AMERICA, AFRICA, ASIA, &c.

LOBNITZ & CO., LIMITED,

Manufacture Dredge Plant. Most Improved Designs.

GOLD DREDGERS.

All parts made to gauge. Quick delivery of standard sizes.

Address Letters —

LOBNITZ & CO., LTD., RENFREW, SCOTLAND.

Telegraphic Address:
LOBNITZ, RENFREW. A1 Code used.

Japanese & English Editions Circulating throughout Japan.

Five times greater than any other Foreign Journal.

聯合有力

THE ANGLO-JAPANESE GAZETTE

日英新報

A MONTHLY REVIEW DEVOTED TO THE COMMERCIAL & SOCIAL INTERESTS OF THE BRITISH EMPIRE AND JAPAN

Send for Specimen Copy

39, SEETHING LANE, LONDON, E.C.

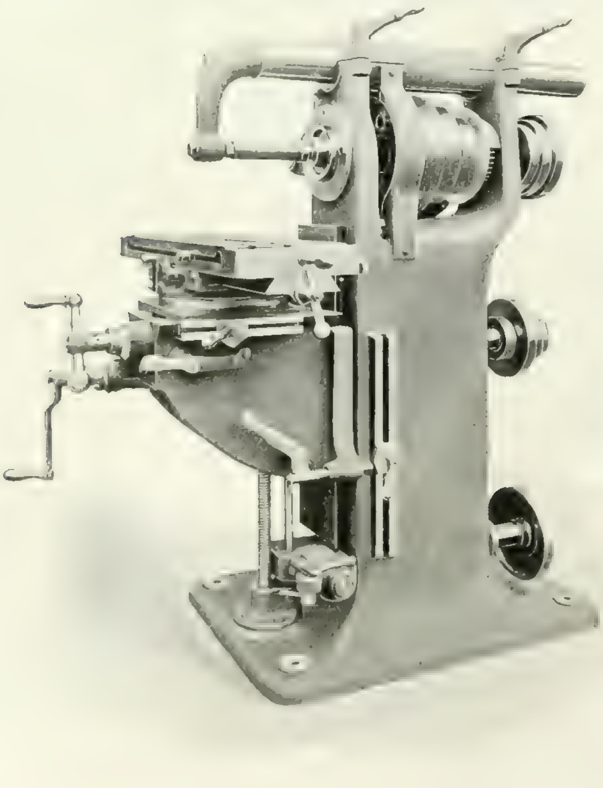
Telegraphic Address "K...MON LONDON" Telephone 1861 CENTRAL

"THOMPSON" DISH ENDED LANCASHIRE BOILERS

can be supplied ex-stock. Advantages: Overcomes grooving on end plate and cracking of flue flanges; freedom for expansion; no stay plates or leaky stay rivets; firebox easily cleaned.

JOHN THOMPSON, WOLVERHAMPTON

For Particulars of Foreign Circulation see Special Announcement this month on Coloured Paper.



A SIGN OF THE TIMES.

THIS YEAR,
From January 1st
To October 10th,

Our OUTPUT of MILLERS

HAS BEEN

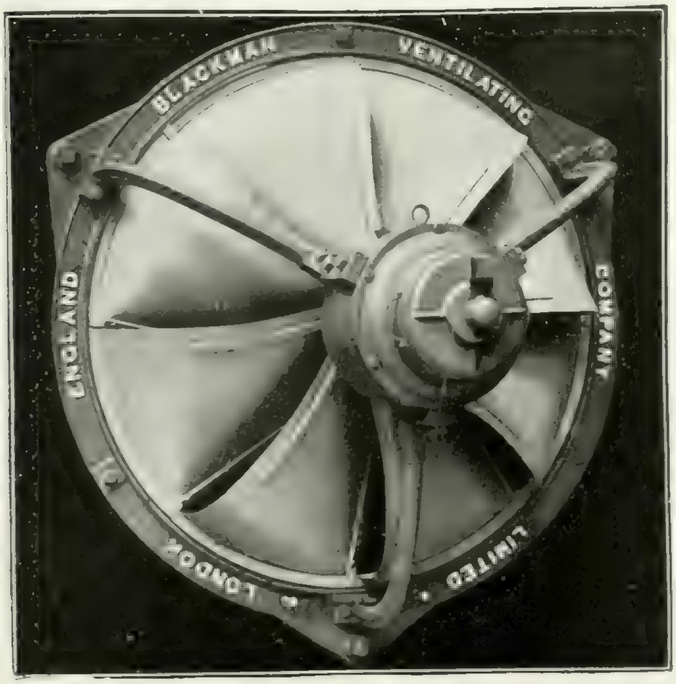
127 Machines.

J. PARKINSON & SON,

Shipley, Yorks, Eng.

INDEX TO ADVERTISERS

BLACKMAN ELECTRIC FANS



(Or Belt Driven)

FOR VENTILATING.

OVER **60,000** IN USE.

MOST CONVENIENT, EFFICIENT, & ECONOMICAL.

GOLD MEDAL PARIS, 1900.

JAMES KEITH & BLACKMAN CO. Ltd.,

Specialists in Heating, Ventilating and High Pressure Gas Lighting,

27, FARRINGDON AVENUE, LONDON, E.C., And BRANCHES.

Works: HOLLOWAY, N.
Foundries: ARBROATH.

MATTHEWS & YATES, Ltd.,

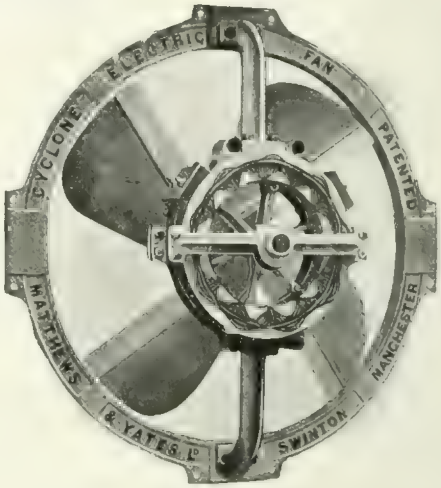
Swinton, MANCHESTER.

Alternating Current Fans

Any SIZE . . .
Any VOLTAGE
Any PERIODICITY.

INDUCTION MOTORS.

Send for Catalogue of other Specialities.



These Fans, having no rubbing parts for electrical contact, and being fitted with oil ring bearings, will run for months without attention.

SHONE PNEUMATIC EJECTORS

FOR RAISING SEWAGE, SLUDGE, WATER &c.

"As used for the drainage of EASTBOURNE, BOMBAY, RANGOON, SOUTHAMPTON, CAPE TOWN and many other Towns.

COMPRESSED AIR LIFTS

for raising water from WELLS, BOREHOLES &c.

AIR COMPRESSING MACHINERY

FOR ALL SERVICES.

HUGHES & LANCASTER

47, VICTORIA STREET, — LONDON, S.W.

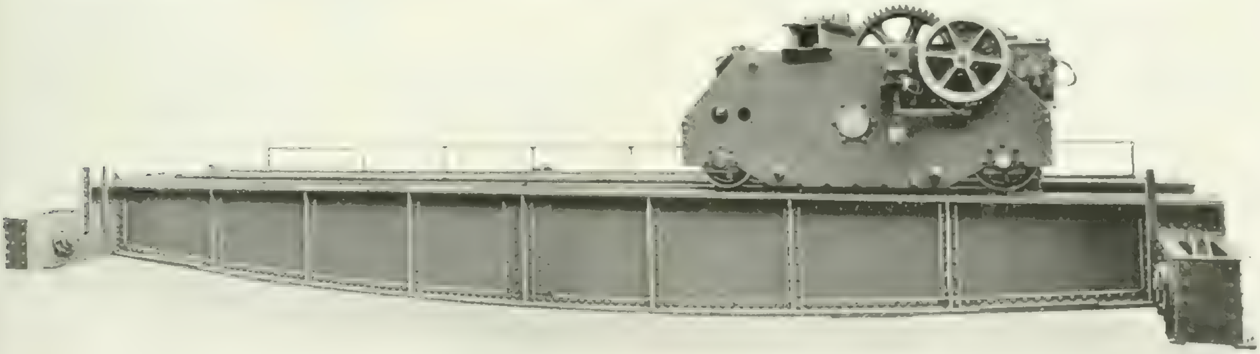
Estimates & Particulars on application.

Index to Advertisers—(Contd.)

HENRY BERRY & CO., Ltd.,

Croydon Works, LEEDS.

Specialities: **HYDRAULIC MACHINERY & ELECTRIC CRANES.**



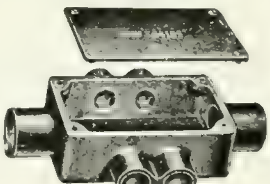
60 Tons Three-Motor Electric Crane.

PRICES, PARTICULARS, AND LISTS ON APPLICATION.

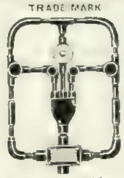
Index to Advertisers--(Contd.)

SIMPLEX STEEL CONDUIT Co., Ltd.,

SIMPLEX FOR INTERIOR



TRADE MARK



SIMPLEX

Send for New Abridged List with I.E.E. Rules

CONDUITS ELECTRIC WIRING.

The SIMPLEX STEEL CONDUIT SYSTEM is the most complete system made. It consists of 10 grades of conduits and nearly 1,000 standardized fittings.

Awarded Gold Medal, International Fire Exhibition, London, 1903.

of 80, DIGBETH, BIRMINGHAM, 20, BUCKLERSBURY, LONDON, E.C.

And at MANCHESTER, LIVERPOOL, & GLASGOW.

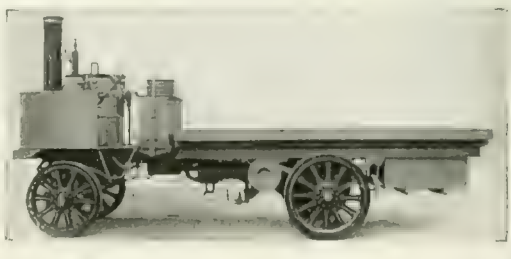
General Manager's Office: WESTINGHOUSE BLDG., STRAND, W.C.

THE THORNYCROFT STEAM WAGON CO., Ltd.

Makers of all kinds of Steam Vehicles for Commercial Purposes, Lorries, Vans, Drays, Municipal Tipping Dust Vans & Water Wagons. Loads from 1 ton to 7 tons.

ALL HIGHEST AWARDS SINCE 1898.
TWO MORE GOLD MEDALS AT LIVERPOOL TRIALS 1901
AWARDED FIRST PRIZE (£500) IN WAR OFFICE COMPETITION OF MOTOR LORRIES.

London Office: HOMEFIELD, CHISWICK, W.
Works: BASINGSTOKE, HANTS.



A Few Pointers

ON

Metallic Packings.

Point I. Buy the BEST.

Point II. The BEST is the CHEAPEST.

Point III. The UNITED STATES METALLIC PACKING is the BEST, and therefore the CHEAPEST.

The United States Metallic Packing Co., Ltd.,

Soho Works, **BRADFORD.**

Index to Advertisers—(Contd.)

SIMPLEST & . .
MOST DURABLE **METALLIC PACKING**

For all Classes of Engines. Many Thousands in Use.

THE UNITED KINGDOM SELF-ADJUSTING ANTI-FRICTION
METALLIC PACKING SYNDICATE, LTD.

14, Cook St.,
Liverpool.

B&S.
TRADE MARK

High-class **LUBRICANTS**

For Machinery of Every Description.

NOTICE.—During the recent trials of H.M.S. "VIPER," when her Engines developed 12,000 Indicated Horse-power, and the Admiralty mean speed for the six runs showed 36·581 knots, or a velocity equivalent to 43 miles an hour, our Lubricating Oil was used with most satisfactory results.

BLUMANN & STERN, Ltd., PLOUGH BRIDGE, **DEPTFORD, LONDON,** S.E.

Telegrams: "BLUMANN, LONDON." Telephone No.: 62 DEPTFORD.

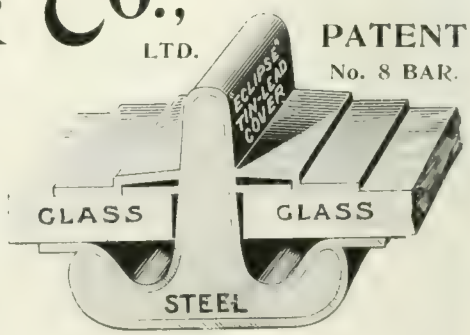
MELLOWES & Co., LTD.

"ECLIPSE" ROOF GLAZING

NO PUTTY,
NO PAINTING,
NO MAINTENANCE NECESSARY.

SHEFFIELD (Works).
LONDON: 28, Victoria St.,
Westminster.

PATENT
No. 8 BAR.



MAGNOLIA METAL..

Best Anti-Friction Metal for all Machinery Bearings.

"Flower" Brand.

TO PREVENT IMPOSTURE, SPECIFY "MAGNOLIA METAL, FLOWER BRAND."
BEWARE OF IMITATIONS! GENUINE ORIGINAL METAL ALWAYS IN THIS FORM OF INGOT.

"Flower" Brand.

The Name and Trade Mark appear on each Box and Ingot.

Magnolia Anti-Friction Metal Company, of Great Britain, Limited,

49, QUEEN VICTORIA STREET,
LONDON, E.C.

Telephone: 5925 Bank. Telegrams: "MAGNOLIER, LONDON."

BERLIN: FRIEDRICH STRASSE, 71. PARIS: 50, RUE TAITBOUT.
LIEGE, BELGIUM: 36, RUE DE L'UNIVERSITE.
GENOA, VIA SOTTORIPA: 1, PIANO NOBILE.

ESTABLISHED 1860. TEL. ADDRESS: "LOCO., LEEDS.

HUDSWELL, CLARKE & Co., LTD.,

RAILWAY FOUNDRY, LEEDS.

LOCOMOTIVE ENGINES,

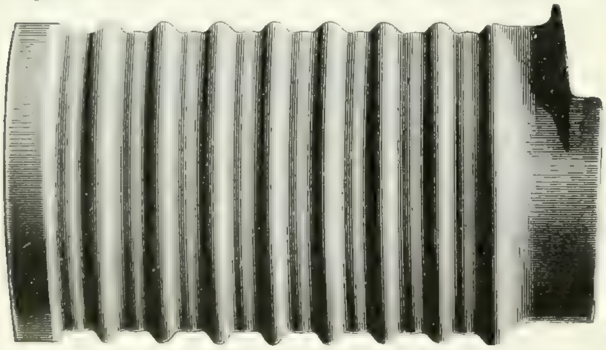
Of all sizes and any gauge of Railway, of greatly improved Construction, for Main or Branch Railways Contractors, Ironworks, Collieries. Prices, Photographs, and full Specifications on application.

SOLE MAKERS OF THE "RODGERS" PULLEYS (Registered).

Wrought Iron throughout, Rim, Arms, and Boss.

ALSO "ETCHELLS'" NON-DRIP BEARINGS, SHAFTING, AND ACCESSORIES.

Telegrams "FLUES, LEEDS." Telephone (National) 1674. A 1 & A B C Codes used



ASHLIN 1897 PATENT WITHDRAWABLE FURNACE

Deighton's Patent Flue & Tube Company, Ltd.

DEIGHTON'S PATENT FURNACE.

The Destructive Tests have proved the DEIGHTON FURNACE to be the strongest to resist collapse ever made.

It is also unequalled for Uniformity of Thickness and Easy Scaling.

MAKERS OF MARINE and LAND BOILER FURNACES.

Awarded 2 Bronze Medals, Paris Exhibition, 1900.

Vulcan Works, Pepper Road, LEEDS.

The "Kingston" Patent Dredger & Excavator.

"Kingston" Dredger and Grab

fixed upon a Hopper Barge of 150 tons capacity having separate propelling engines and special boiler, as supplied to the Spanish Government

Sole Manufacturers and Patentees -

ROSE, DOWNS & THOMPSON, Ltd., Old Foundry, HULL, and . . . . . . 12, Mark Lane, LONDON.

Photo by Sir W. G. Armstrong, Whitworth and Co. Ltd.]

LAUNCH OF THE NEW CRUISER H.M.S. "HAMPSHIRE" AT ELSWICK BY LADY LONDONDERRY.

On the platform are Sir Andrew Noble and Mr. Perrett. Immediately in front of the platform are (from left to right) Mr. Vincent, Admiral Hikmet Pasha (to the left of stairway), Mr Arthur Vere (to the right of stairway), Captain Fegen, R.N., Captain White, R.N., with Captain Horner, R.N. (in bowler hat) on his immediate right. A little to the right of platform (wearing silk hat) is Sir W. H. Stephenson, Mayor of Newcastle.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

Vol. III. LONDON, NOVEMBER, 1903. No. 5

THE NEW DOCKYARD AT GIBRALTAR.

BY

JOHN LEYLAND.

The author discusses the Admiralty plan for constructing a harbour and dockyard on the west side of the Rock. He incidentally deals with the controversy which arose as to the position chosen for the works and the alternate proposal for the formation of a harbour on the east side. A description of the works now completing on the west is deferred to a second article.—Ed.

I.

THOSE who knew Gibraltar ten years ago would be surprised on visiting it now to find the remarkable transformation which has passed over the place. The huge, bare, over-populated Rock is there, still frowning over the bay, still looking out to the range of the Sierra Carbonera and the Queen of Spain's Chair. There is still shade in the walks of the Alameda, and still the same stream of varied Mediterranean life flows between the Southport Gate and the Waterport, but, from the Ragged Staff southward almost to Rosia Bay, the sea front has been completely altered from its former state. A wonderful change has been produced by the construction of the Admiralty harbour, docks, and dockyard, which are still in the full tide of progress, presenting larger, more varied, and more interesting engineering works of the kind than are in progress anywhere else in the world.

THE IMPORTANCE AND VARIED MAGNITUDE OF THE WORK.

Practically a new dockyard and harbour are being called into existence, involving an immense variety in different classes of work, both temporary and permanent, including the building of breakwaters, docks, quays, retaining walls, stores, factories, boiler shops, and a pumping station, the displacing of the sea and reclaiming of the land, dredging, blasting, quarrying, tunnelling, bridge work, railway construction, concrete blockmaking, drainage, water supply, lighting, and much else. A vast deal has already been accomplished, but much remains yet to be done. One of the three dry docks, the smallest, of which His Majesty laid the memorial coping stone on April 9th last, will soon be ready for use. It is now called King Edward's Dock. The steel caisson for closing the entrance was being erected when I saw it recently. The workshops and stores are approaching completion, and the great pumping station is ready to begin its work. The South Mole, once called the New Mole, and the Detached Mole are practically finished, while the Commercial Mole, completing the inclosure of the harbour, which will be handed over to the Colony of Gibraltar for coaling and commercial purposes, is well advanced towards completion. A fine illustration of what has been achieved in forming the grand harbour was recently afforded by the presence there of the whole Mediterranean fleet, many of the ships lying in the harbour and alongside the moles.

Mr. Gibson Bowles, M.P.—who has taken a very strong line in regard to Gibraltar, but with whose opinions I cannot altogether agree—has said with great truth that there is probably no spot on earth outside

Photo by Beanland, Gibraltar.]

THE NEW HARBOUR AND DOCKYARD, WITH THE MEDITERRANEAN FLEET.

The temporary Dam and King Edward VII. Dock are seen on the left.

Photo by Beanland, Gibraltar.

THE ALAMEDA PARADE AND HARBOUR FROM BELOW MIDDLE HILL.

The Spanish Shoe in the distance.

GIBRALTAR.

Sketch Map showing the new Docks, Dockyard, and Harbour ; also the suggested Harbour on the Eastern side.

[illegible] A PANORAMIC VIEW OF THE [illegible]
Showing the D[illegible]

the British Islands—and certainly none of similar extent—which the British people prize so highly as Gibraltar. Let strategists contend that Ceuta would answer our purpose as well, and Minorca perhaps better, but nothing, says Mr. Bowles, would ever persuade the British people to part with their Rock in exchange for either of those places, nor for much more to boot. For Gibraltar represents at once the glory of the past, the power of the present, and the security of the future. It is regarded as a sure proof of naval predominance that we have held it so long, and as the most certain pledge of our sea rule that we continue to hold it. English people have the settled conviction that upon the retention of Gibraltar depends not only the Naval position of Great Britain in the Mediterranean, but also her access to the East through the Suez Canal.

We must dismiss from our minds any idea that Gibraltar is the key of the Mediterranean. It has no value apart from the fleet, of which it is the great strategic base, and to this consideration the great Naval works, which I propose to describe in some detail in a subsequent article, are altogether due. Gibraltar is a position of signal importance upon the most valuable commercial route in the world. It is a place at which the ships of His Majesty's fleet may be coaled, victualled, supplied with stores and ammunition, and, in case of need, be repaired in security. Its strategic importance is indicated by the fact that it lies in the mid-position of a vast strategic theatre—between the divided fleets of Russia, between the two fleets of France, and between Germany and her purposes in the East.

But the changed conditions of naval warfare had deprived old Gibraltar of much of its value. It possessed no dock that could receive modern leviathans, no workshops through whose agency they could be thoroughly overhauled and repaired, and no harbour wherein a fleet could lie secure from torpedo attack. In short, one of the most important positions in the organisation of our imperial defence had so far fallen behind in the march of progress as to become a source of weakness rather than of strength. Vast sums of money had been spent on ships and guns, and sound national policy had demonstrated that in that direction should be exerted all the effort we could then command. But even here it was necessary, if not to call a halt, at least to prepare for a great expenditure on shore upon vast engineering works. Ships are now more than ever dependent on their bases. Their calls for coal are constant, and their demands for docking facilities and the care of dockyard hands, are more insistent than ever. Hence it is that we see such great works in progress at Portland, Keyham, Dover, Gibraltar, Malta, Colombo, Simon's Bay and Hong Kong, and that a new base at Rosyth, on the Firth of [illegible].

THE ADMIRALTY PLANS AND PECUNIARY PROVISION.

Many plans were put forward for adapting Gibraltar to the needs of the fleet, and it was decided to form a harbour and create a dockyard on the west side of the

GIBRALTAR FROM THE [illegible] MOLE
(on the extreme right)

Rock, where our power has been so long established. A plan was presented to Parliament in 1895, involving an expenditure of £1,435,000, being £1,074,000 for the harbour moles, and £361,000 for a dry dock, to be built in the southern angle of the harbour between the so-called New Mole and the shore. This scheme was sanctioned and embodied in the Naval Works Act of that year. It was revised, however, in 1896, when the new Government, having in view the growing needs of the fleet and the contemplated increase of force in the Mediterranean, proposed that three docks should be constructed instead of one, raising the expenditure upon that head to £2,674,000, and increasing the total cost to £3,748,000. But, even with this great expenditure, the scheme was not complete, for, in the next year, a further sum of £669,000 was demanded for the Commercial Mole on the north side of the harbour, of which, however, four-sevenths are to be repaid by the Colony of Gibraltar in the form of an annuity of £14,000 per annum for fifty-seven years from the opening of the mole for use, presumably in 1903–4, which annuity will be credited as an appropriation in aid of the votes. It will, perhaps, not be overstating the case to say that the total outlay upon these vast works will approximate to £6,000,000 before they are completed. Gibraltar undoubtedly presents some disadvantages. It is, in the first place, a dockyard dependent upon its supplies, both of men and materials, being drawn from oversea, or from a foreign country. Of the four thousand or five thousand men employed upon the works, all, save a small proportion, are Spaniards, who cross and recross the neutral ground daily, going to and fro between Gibraltar and the Spanish town of Linea, or who cross the bay by boat from Algeciras. From the same source are drawn the busy gangs employed in coaling the ships at the moles, and, though they may not have the vigour of some British workmen, they are certainly, taking them all round, an excellent class of fellows.

OPPOSITION TO THE PROPOSALS.

A more serious drawback was pointed out, by those who considered the increasing range of guns and the unchanged distance between Gibraltar and the Spanish coast round the bay. This is a matter into which, perhaps, it is unnecessary to enter at great length, but something must be said about it, because it concerns the value and safety of great engineering works. The contention put forward by Mr. Gibson Bowles was that these works were within range of Spanish guns, planted or to be planted, on the hills partly surrounding the bay, from the Queen of Spain's Chair on the Sierra Carbonera in a curved line for nearly one-third of a complete circle, along the northern and western side of the Bay of Gibraltar, and through the town of Algeciras, to Punta Carnero—a distance of some thirteen miles, the ranges varying from 6,000 to 10,000 yards. Behind the low foot hills on the Spanish shore heavy guns could be concealed, the positions of which it might be very difficult to discover. It is known that Spanish officers have laid down plans, and that British officers have established proposals,

in case of hostilities, for landing a great force of men, and seizing the Spanish possessions. For obvious reasons, these are matters not to be discussed here.

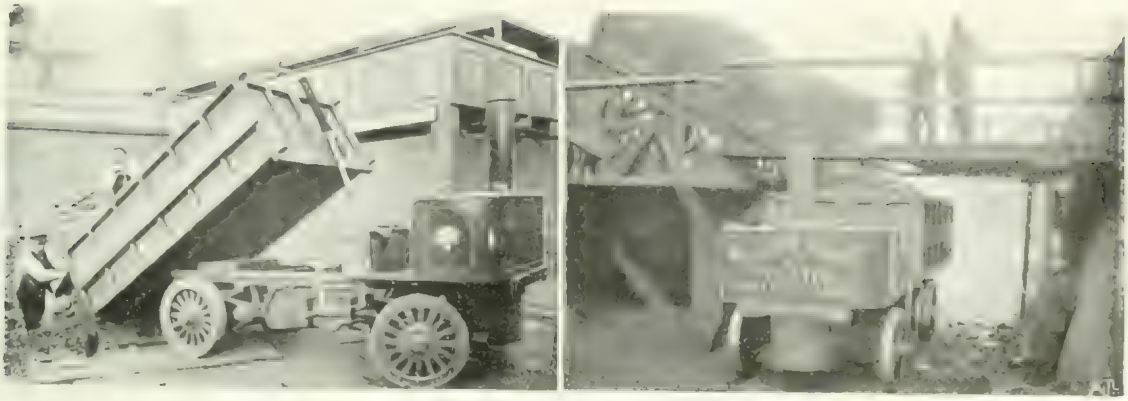
The question having thus been raised, the Admiralty sent out Vice-Admiral Sir Harry Rawson to hold an inquiry into the question, in which he was assisted by Major-General Sir William Nicholson, K.C.B., Mr. William Matthews, C.M.G., and Mr. Gibson Bowles. The conclusion was that it was inadvisable to complete all the works that were planned—that is, three docks and a complete provision of stores and workshops—and that a harbour should be constructed on the eastern side of the Rock, with a graving dock and certain stores and shops.

This proposal for a complete reversal of the policy adopted created very naturally a considerable amount of public discussion. There is doubtless very much to be said in favour of both aspects of the question. It is not supposed that Spain has any purpose of menacing our works at Gibraltar, and British officers are convinced that the magnificent new guns placed upon the Rock would command and silence any guns which the Spaniards could bring to bear. If it had been desired to place the harbour and docks on the east side of the Rock that would have been feasible, although the difficulty of the shore, and the effect of the Levanters, as the winds from the east are called, would have made the construction very difficult. There does not seem to be any disposition—nor, in my view, any necessity—for the Admiralty to reverse its policy. Every necessary inquiry has, however, been made, and I shall conclude this article by summarising the report of Captain T. H. Tizard, C.B., F.R.S., R.N., and Mr. William Shield, M.Inst.C.E., F.R.S.E., on the proposed eastern harbour and dock, which was presented to the Admiralty in June, 1902.

ALTERNATIVE PLANS.

These gentlemen took account of all the conditions which could affect the construction of such a harbour and dock—wind, waves, working weather, tidal streams and currents, tides, the travelling of sand, and soundings, and they came to the conclusion, after making a careful survey of everything that could affect the works, that they were feasible, and could be carried out, as they thought, within ten years, at a cost not exceeding £6,500,000, a sum which, of course, unforeseen circumstances might have considerably increased. But the large amount named, all other circumstances being put on one side, was far too great to be incurred, in addition to the huge sum being expended on the western side. The proposal was to run out a breakwater, 11,000 ft. long, commencing about 100 yards north of Catalan Bay, in a direction about S.E. for 2,100 ft., and then sweeping round by a curve to a straight line almost north and south, and ending with a circular head opposite to Windmill Hill. There were to be sluices, capable of being opened and closed to insure the proper circulation of water, and the exclusion of sand, and a spur 300 ft. long and about 1,000 ft. from the termination of the breakwater, was to run out at right angles towards the shore in order to check the effect of wheeling waves along the inner face of the breakwater. Another breakwater, 1,800 ft. long, was to run out in an easterly direction from the rocks below the old First Europa Advance Battery, towards the spur already referred to, leaving an opening to the harbour 700 ft. wide. The area of water inclosed was to be 466 acres. There was also to be a graving dock, 700 ft. long, with an entrance 95 ft. wide, and a depth over the sill of 38 ft. at low water, opening in a north-easterly direction, so as to protect it from direct torpedo attack, even if an enemy's boats should succeed in entering the harbour. The cliff would have had to be cut away for the work, and land reclaimed from the sea. Space might thus have been found for two other docks, and the area recovered by quarrying would have been suited as a site for the erection of workshops and heavy machinery. This proposed dock and the dockyard works would have been in the south-western corner of the proposed harbour, and a new tunnel was to be constructed from that point, enabling a railway line to be carried northward to the opening of the existing tunnel, which was to be enlarged to admit of two lines of railways being carried through to the western side of the Rock.

I shall not describe the proposed harbour and dock any further. Captain Tizard and Mr. Shield are to be congratulated upon the exhaustive inquiry they made, and upon the careful proposals they put forward, which are of great engineering value. Inasmuch, however, as the dockyard on the western side is that which is actually being completed, under the supervision of Mr. A. Scott, M.Inst.C.E., the Admiralty Superintending Civil Engineer, it possesses, of course, the real interest, and the account of it which I propose to give in the next article will show what vast and important works the new dockyard and harbour are. If they are open to fire from the Spanish shore the same would have been true in lesser degree of the harbour on the east side, of which the north-eastern part would be exposed to attack from the Sierra Carbonera, while the whole of it could be enfiladed from the lower hills extending east. Only the dock and adjacent ground would be protected, and they, of course, would be vulnerable from the sea.



ONE OF THE LANCASHIRE STEAM MOTOR COMPANY'S TIP-WAGONS.
(A) Delivering coal at the Preston Gas Works, and (B) being loaded at the coal siding.

MOTOR TRANSPORT FOR GOODS.

BY

DOUGLAS MACKENZIE.

The economic position of motor vehicles is here discussed, and the illustrations show typical examples of the most recent productions in this field. The author has also something to say about the difficulties of maintenance, and he includes a useful table on the average cost of working motor vehicles. With regard to the new regulations affecting these vehicles, he considers that a much wider tyre than that at present specified and a larger diameter of wheel should be made obligatory.—ED.

WITH the introduction of the Light Locomotives Act of 1896 a new field was opened for engineers in the construction of vehicles that could take advantage of the removal of the previous restrictions to mechanical traction. Whilst the number is legion of those who have devoted their energies to passenger vehicles, the number of those who have tackled the goods transport vehicles is comparatively limited. The firms who had had previous experience of mechanical transport on roads, namely, the traction-engine makers, seem to have agreed that no satisfactory engine could be constructed to carry a paying load and at the same time come within the limitations of the Light Locomotives Act. It was not until the Act had been in operation some time that three of the traction-engine makers produced light locomotives, and they were all of the young traction-engine type.

The fact is, that the stresses induced by road transport with heavy loads are so great that hitherto they had always been met by increased stiffness and weight, and when weight was to be kept down to a specified limit the problem assumed awkward proportions. Fortunately many other brains were prepared to boldly attack the problem, and, accumulating experience with every one made, they have gradually produced vehicles that are practical and useful machines.

The figures, however, that are available as to expenses of operating these motor-transport vehicles are either quite unreliable or are too indefinite to be of value to those who would wish to ascertain if motor wagons would be of service to them in their respective businesses, and, therefore, it is the author's endeavour to adduce such experience and figures as are necessary in order to gauge the field that now exists for motor transport in England.

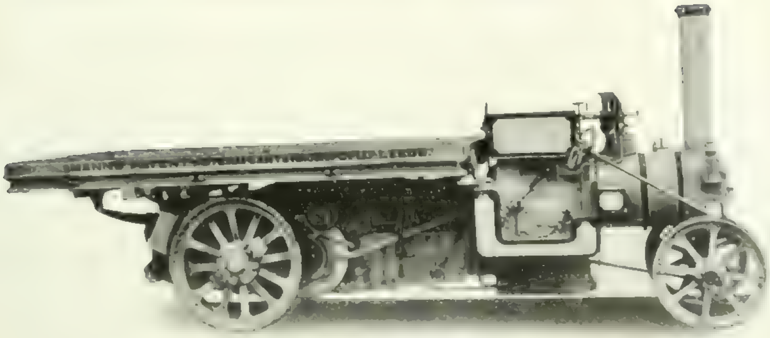
LEGAL RESTRICTIONS.

It is first necessary to briefly review the statute law relating to motor transport, and to consider the effect thereon of the passing of the Motor Car Act, 1903. The Locomotives on Highways Act, 1896 (better known as the Light Locomotives Act), and the Motor Car Act, 1903, are now to be known collectively as the Motor Car Acts, 1896 and 1903. Under these Acts a motor vehicle is negatively defined as (*a*) not exceeding three tons in weight, unladen; (*b*) not used to draw more than one vehicle; and (*c*) not emitting smoke or visible vapour, except from any temporary or accidental cause.

The Local Government Board have further enacted that, (*a*) the vehicle shall be capable of being propelled either backwards or forwards (vehicles weighing less than five cwt. do not come within the scope of this paper); (*b*) it shall not exceed six and a-half feet in width; (*c*) it shall have two efficient brakes; (*d*) the tyres shall be smooth, and of certain specified widths.

The 1903 Act gives power to the Local Government Board to increase the maximum legal tare weights, subject to such regulations as to construction, use

A CORN MILLER'S WAGON TO CARRY 5 TONS—BUILT BY MANN'S PATENT STEAM CART AND WAGON COMPANY, LTD., LEEDS.



A COLONIAL TYPE OF LORRY TO CARRY 3 TO 4 TONS—BUILT BY MANN'S PATENT STEAM CART AND WAGON COMPANY, LTD., LEEDS.

and speed as [illegible]. Under the 1903 Act, all motor vehicles must be registered and have a number plate affixed, and the drivers must each provide themselves with a license. The regulations as to lights, gongs, reckless driving, stopping in case of accident, etc., are only reasonable, and require but passing mention.

One striking innovation of the 1903 Act is that it extends the application of both this and the 1896 Act to servants of the Crown. It is a principle of English law that statutes do not apply to Crown servants, unless it is specially so provided therein, and therefore the Post Office have hitherto had the power and the War Office have indulged in the practice of using motor vehicles exceeding three tons in weight unladen, and of travelling at much greater speeds than the ordinary public were permitted. Previous to 1896, all mechanically propelled road vehicles were under the Locomotives Acts, 1861 to 1878, and were limited in speed to four miles an hour in the country and two miles an hour in towns and villages, and required a man with a red flag in front as well as being subject to licensing enactments which are to this day a blot on English legislative ability.

There has also been a strong prejudice on the part of the horse-worshipping English against the traction engine, and to this day its use is hampered in every way that prejudice can suggest. Many local authorities, the Middlesex County Council to wit, have done everything in their power to keep traction engines out of their district, and if a progressive trader brings a traction engine into Middlesex, or Bolton (Lancs.), and many other places that could be named, he will find his engine watched by every surveyor and roadman to see what claims can be made out against him.

VARIOUS TYPES OF MOTOR GOODS VEHICLES.

There being [illegible] previous to 1897 for any mechanically propelled goods vehicles, other than the traction engine, many of the vehicles since produced have been quite experiments; but we can now, with six years' experience, see that several types have come to stay.

First there is the light delivery van, with an internal combustion engine, and not weighing more than one ton unladen. These are practically ordinary motor cars with the substitution of the van body for the passenger seats, and any improvement in motor-car engines or design is equally applicable to these vans. They are fitted with the usual change speed gears and in most cases with rubber tyres.

Next, in point of size, are the heavier lorries, with internal combustion engines, weighing from one to two tons unladen, and capable of carrying two to three tons of paying load. Generally these are fitted with special bodies to suit individual trades, and a fair number are now in use.

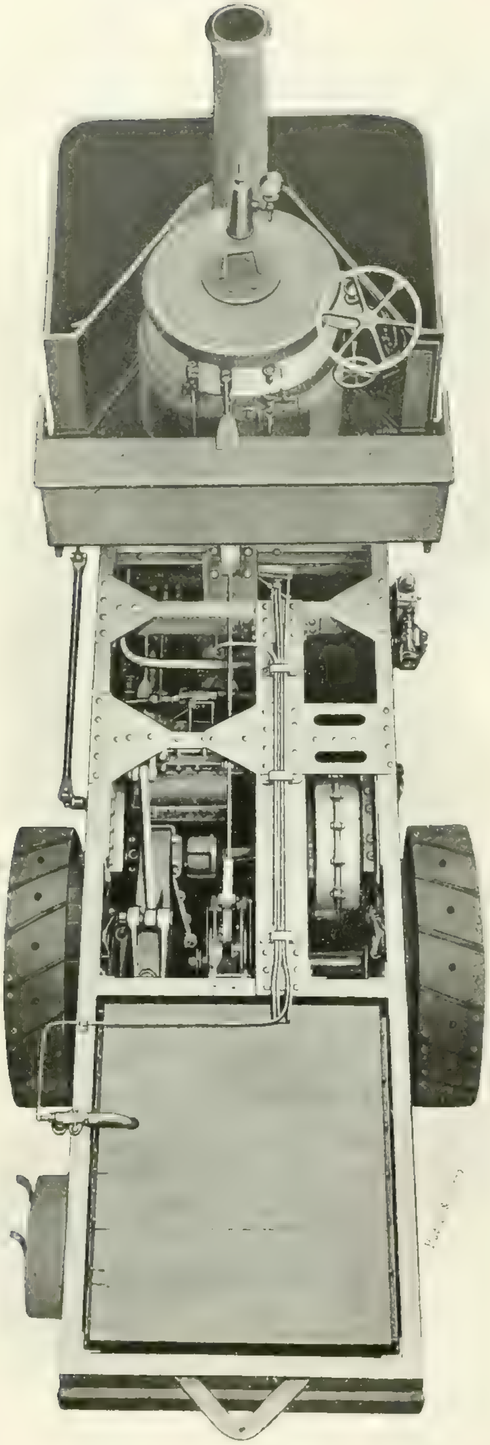
The next type are steam lorries, weighing about two tons unladen, and carrying from two to three and a-half tons of paying load. These are generally oil-fired, and have not power to pull a loaded trailer. They may be regarded as equivalent in capacity to an ordinary pair or three-horse lorry, though they will get over more ground in the same time than will the horse-drawn vehicle.

The next are the large size of steam motor wagons, weighing, when stripped to comply with the Act, three tons, and capable of carrying from three to seven tons of paying load, and pulling in addition from two to four tons on a trailer.

Lastly there is a special type of vehicle, which is most accurately described as a "young traction engine." It is practically a traction engine, lightened and reduced in dimensions to come under the Motor

A TIPPING-WAGON MADE BY THE STRAKER STEAM VEHICLE COMPANY, LTD.

In a recent test it carried a load of 5 tons up a gradient of 1 in 7½ with ease, holding steam well.



A THORNYCROFT COLONIAL WAGON FROM ABOVE.

Car Acts, carrying no load itself, but capable of pulling from three to four and a-half tons on a suitable trailer.

It is not the author's intention to go into the details of the design and construction of these vehicles (that would require a weighty volume), but rather to consider the economics of their employment, and to show where they can, and where they cannot be profitably employed.

SPHERE OF USEFUL EMPLOYMENT FOR EACH TYPE OF MOTOR VEHICLE.

In considering in what sphere each type of vehicle can be and is best employed, it must be remembered that evolution has not yet had time to weed out many of the experimental types, and therefore it is difficult to draw a hard-and-fast line between each class. Rather, one type merges into another, some intermediate in character, either of design or of function, joining them up.

The light delivery van is usually employed to deliver small parcels or packages within a limited radius, in London say within six miles, and in other towns say within four miles of headquarters. Consequently the driver only needs to know how to steer, regulate the engine, and to see that the automatic lubricators are filled up and working properly. Any adjustments or repairs can be carried out at the stables or at some convenient engineer's shop. The driver, though paid higher wages than the ordinary carman, is not as expensive as a fitter, and sees to the cleaning of his van. The motor delivery van is regarded as a good advertisement, a sign that the firm is up to date and pushing, and therefore has a value quite apart from its economy.

If the driver keeps his eye on the sight-feed lubricators and the petrol tank, the motor van never becomes tired, and can be worked longer hours than the horse, the driver generally being paid overtime. The motor van also gets over the ground quicker, but the calls are so frequent, and consume such a large proportion of the time, that a motor van will, in the same time, only get through about five per cent. more work than a horse. Any trader should know the cost of a horse delivery van, calculating interest and depreciation in horseflesh and van, horse fodder and bedding, wages, upkeep of van and harness, and rent of stabling. This varies very much in different places, and depends very much on the way the trader manages this department of his business. With the motor he must calculate interest on capital and depreciation, repairs and renewals, wages, petrol, lubricating oil, and rent of stabling.

Allowing that with longer hours and increased speed, the motor is able to do twenty-five per cent. more than the horse, the trader is entitled to reduce the charges against the motor, for the purposes of comparison, by twenty per cent. Even making this allowance, the author has not been able to hear of any case where the motor delivery van has been really an economical success. In cases where such has been suggested, he has found that no allowance had been made for interest and depreciation, or that some

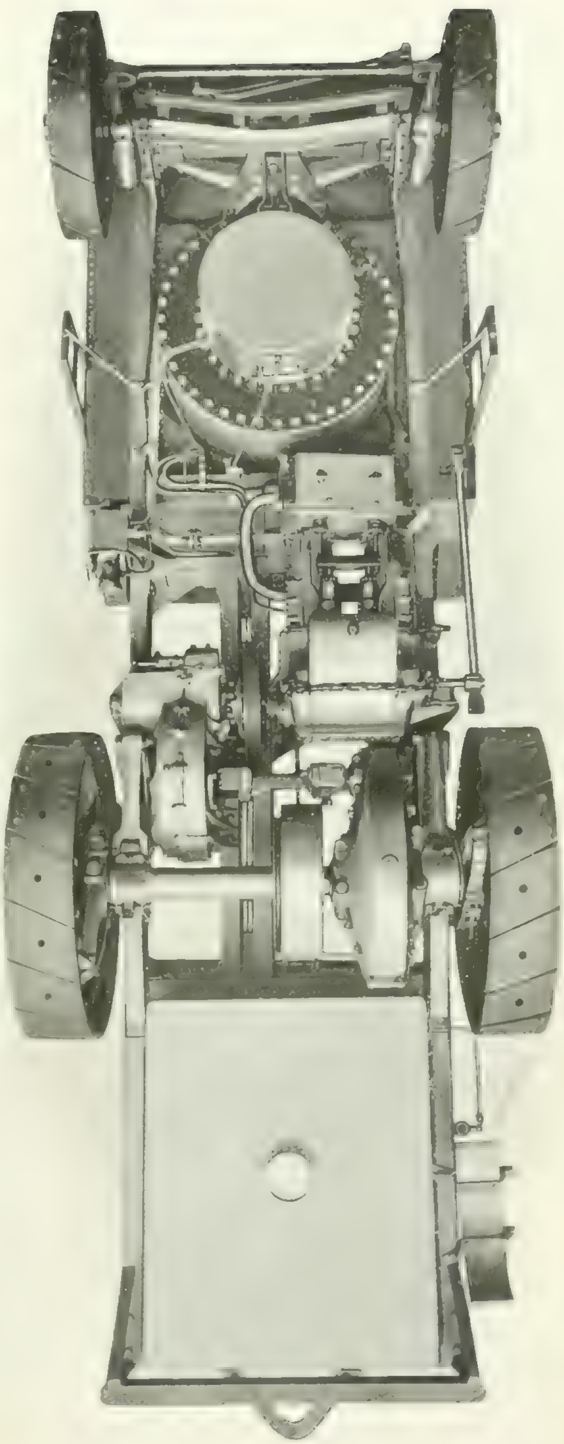
such error had crept in. By deducting the charges against the horse vehicle from those against the motor (reduced as aforesaid), the user can get at the cost of his advertisement, and he generally finds it a very expensive form of advertising.

The next type of vehicle is the motor lorry with internal combustion engine, which carries up to three tons of paying load. On the Continent it has been pushed in preference to the steam lorry, but it is not much in evidence here as yet. The author gathers from those who have them in use, that when a fair allowance is made for depreciation, interest on capital, and for repairs and renewals, they cost more per ton-mile than do horses, but they can take a pair horse load considerably quicker, and on long runs of from fifteen to thirty miles there is no necessity to stop for resting, as with horses.

They have another advantage, apart from economy, in that where goods would otherwise be sent by rail, delivery can be guaranteed. Goods when sent by rail have often to go over several systems, and then take from two to five days to travel thirty miles, so that though railway rates, even with cartage at both ends, may not cost as much as motor transport, yet the certainty of delivery may decide in favour of the motor. For their efficient employment on such work it is essential that the driver should be a skilled motor mechanic, capable of detecting at once from the beat of his engine anything that is not quite right, and of remedying it immediately. He will not always be close to his yard or stabling, as the light delivery van is, and may be miles from any engineer's or a motor repair shop. Wages must therefore be high, and renewals a heavy item.

The lighter steam lorries, carrying from two to three and a-half tons of paying load, are generally oil-fired. The burners, however, require constant attention to keep them in order. If paraffin or kerosene is burnt, the cost of fuel is from 3¾d. to 6d. per mile run, which makes the cost of carrying cargo per ton-mile very heavy, if not prohibitive. With the hydroleum burner, recently introduced for burning Texas residue, the cost can be reduced to 1d. or 2d. per mile. For the light loads carried by these lorries, the cost of coal or coke would work out to about the same. They would do a run of about fifteen miles out and fifteen miles back, and the cost of fuel per day may be put at five shillings. This is allowing for the fuel consumed in raising steam, and shunting about to load and unload. If paraffin is burnt, the fuel cost will be proportionately higher.

The boilers of these lighter lorries are necessarily so small that they must be either flash, semi-flash, or water-tube boilers. These all require very careful attention, and cost a great deal for upkeep, and a great deal of extra time has to be spent in keeping them in order. The makers generally give the cost of upkeep as very little, and it might be so with a perfect driver, but these are so rare that they may be left out of practical consideration. But, in addition to the boilers, very delicate boiler fittings are required



UNDERNEATH VIEW OF THORNYCROFT COLONIAL WAGON SHOWING ARRANGEMENT.

FOUR-TON STEAM WAGON, FITTED WITH RAIL SIDES, AND SUITABLE FOR CARRYING FARM PRODUCE—THORNYCROFT STEAM WAGON CO., LTD., CHISWICK.

for these lorries, and the frequent breakdowns due to trouble with the boiler fittings have led many users to give up these lorries. These vehicles really compete with the previous class, petrol lorries, and cost but little less to work. There is a field for them under special circumstances—for journeys of twenty miles and upwards—where not in competition with a direct straight railway service.

The better-known vehicles are the heavy steam lorries, burning coal or coke, and carrying from three to six tons on deck, and able to pull two-thirds as much again on a trailer. Many engineers, with very good reputations, have tried their hands at the design of these motors, and there are many excellent types now at work. The standing charges are so heavy that it does not pay to use them except with full loads. With light loads, or on very short journeys, they are only useful if special circumstances give them some peculiar advantage over other forms of transport.

Where users can make up loads of six tons and upwards it will be found that these motor lorries are more economical than horse haulage, as the terminal conditions will be the same in both cases; that is to say, the delays due to loading, unloading, getting clearance papers, and so forth. But the load must be all from one place and to one place. Stopping to pick up or set down part of the load affords the horses a much-needed rest, and enables them to pull much better afterwards. With the motor, however, it means a deadened fire and cooled cylinders, without any compensating advantage. Under such circumstances horse transport may prove the more economical.

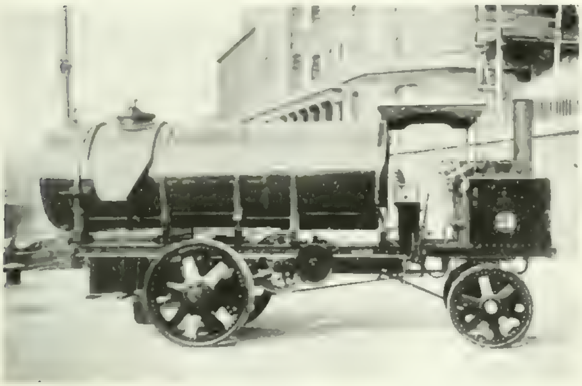
If the journeys are twenty miles or more the motor vehicle would prove more economical than the horse with loads of four tons and upwards. For shorter journeys, of, say, ten or twelve miles, the critical load is five and a-half tons. It must not be forgotten, however, that the railway rates will cut the motor out unless there are special circumstances, as already mentioned, so that on long journeys the motor has to compete with the railway as well as the horse.

Some of these steam lorries are a cross between the traction engine and the steam wagon proper. In these the boiler is of the locomotive type, and, as in the traction engine, forms part of the main frame. The only objection to this type, as a type, is, that viewed from the front, it resembles a traction engine, and so upsets the nerves of many horse drivers, and occasionally of the horses as well. Remembering the way in which traction engines are persecuted in Middlesex and elsewhere, the less the wagon resembles them the better.

There remains the "young traction engine" to review.

This form of motor has a special field of its own. None of the motor vehicles previously mentioned are to be trusted off the hard road. If they get too close to the side on a country road, either the wheels sink

ONE OF THE LANCASHIRE STEAM MOTOR COMPANY'S STANDARD MILLERS' WAGONS AT THE PRESTON DOCKS.



A TANK WAGON—BUILT BY THE STRAKER STEAM VEHICLE CO., LTD., LONDON—FOR CONVEYING TAR OR OIL.

in and have to be jacked out as they get bound in the softer ground, and the engine has not power to pull the loaded wagon out. Again, the wheels will not carry the loaded motor in a gravel pit, brick-field, or unmade road, even where traction engines could go. But the "young traction engine," weighing only four tons with coal and water, and carrying no share of the load, will float over a soft place that would bury a steam wagon, and it has sufficient power to pull its trailer through a soft place if the engine itself can get on firm ground. On the other hand, having less than three tons weight on its driving wheels, it has not sufficient adhesion to pull more than four and a-half tons of paying load, as against the ten tons that the largest size of steam lorries can negotiate.

The designers have been unable to prevent the noise of the sharp exhaust at starting and the rattle of the gear, which are so objectionable in traction engines, and the unmechanical exhibit the same prejudice towards the "young traction engine" as towards its mother. The makers of these claim, with justice, that there is no need to wait to load and unload, and that the motor can be instantly uncoupled from a loaded trailer and coupled to an unloaded one for the return journey, or *vice versâ*. There are many trades where this is a substantial advantage, and therefore there is a distinct field for the employment of this type. They are coming largely into use for market garden produce.

DIFFICULTIES OF MAINTENANCE.

It is essential that steam lorries should not be worked more than five days per week, and that they should be thoroughly overhauled on the sixth. Even then the cost of repairs and renewals would astonish those who have not gone into the question.

A severe tax is put on the boilers on account of their small dimensions. They are pressed to yield the utmost of their steaming capacity on steep hills, and this is often followed by long waits whilst loading or unloading. The author knows more than one lorry where the endurance of the boiler has been so severely taxed that it has been necessary to replace the boiler with a new one three times in as many years. The strains due to the uneven road surface play havoc with the joints on steam, exhaust and pump delivery pipes, and after nearly every journey there is some joint to re-make.

In gear-driven vehicles, there are, necessarily, many extra parts, to allow freedom to the hind axle, under the movement of the springs, whilst ensuring

STEAM MOTOR WAGON—DESIGNED BY THE YORKSHIRE PATENT STEAM WAGON COMPANY, OF LEEDS TO CARRY UP TO 4 TONS, AND TRAVEL 40 MILES PER DAY.

STEAM MOTOR TIPPING VEHICLE—BY MESSRS. T. COULTHARD AND CO., LTD., PRESTON—FOR CARRYING LOADS OF FIVE TO SIX TONS.

MOTOR OMNIBUS BUILT BY THE STRAKER STEAM VEHICLE COMPANY, LTD.

that the gear wheels are kept in mesh. This means so many extra parts to give trouble. On the other hand, the chain drive involves a greater risk. The strength of a chain is that of its weakest link, the wear is very rapid, and they soon get out of pitch. The life of a chain is very uncertain, but in hard work it cannot be taken to average more than eight months.

A good driver should be able to keep the engine and boiler in reliable condition, provided that he has proper help on the sixth day and at other times when necessary, so that he may repair and replace worn and injured parts. It is essential that some competent engineer should supervise the driver's work, and should constantly examine both boiler and engine, and should decide the best shape in which to effect the repairs. Allowance must, therefore, be made for supervision, in estimating costs, and additional fitter's labour must be included under the heading of repairs. At least four weeks in every year will be lost for extensive repairs, such as re-boring cylinders, re-tubing boiler, painting, etc.; but during this time fuel and wages will not run on. In estimating the cost of repairs, depreciation, interest, and insurance, the annual cost can only be spread over [illegible] working days.

DIFFICULTIES OF OBTAINING ACCURATE WORKING COSTS.

It is necessary to emphasise the point that too many factors enter into the question of economical employment to make mathematical accuracy possible. With a stationary engine on a constant load, it is possible to measure the fuel consumption to three places of decimals, to work out $\theta\ \phi$ diagrams and to revel in squared paper, to talk of brake horse-power per pound of fuel, and to eliminate all personal elements. But with motor vehicles, the slipping due to a slight shower, or the obstinacy of a passing coster's donkey, may send up the fuel consumption, and five minutes' difference in the time of starting may so alter traffic conditions as to cause a delay of an hour in arriving. Consequently the questions of profitable employment have had to be answered by the information the author has accumulated from his own experience and that of others, and his opinions on these questions have necessarily been modified from time to time as fresh information came to hand, or fresh facts came to light, and will be further modified in the future as improvements are made in motor vehicles, and as road conditions alter.

It is necessary here to say a few words on the subject of depreciation. The ordinary system of writing off a fixed sum per annum may be very simple accountancy, but does not truly represent the actual value, from time to time, of the plant in question. The anomalies often seen of locomotives on the duplicate stock of our railways, long ago written off the books, but still earning a fair return, and on the other hand, machinery a year old, sold at half its cost, emphasise the error of this system of reckoning. This plan is particularly inapplicable to motor vehicles. Many makers say the life of their vehicles can be put at fifteen years; that would make the depreciation on the usual reckoning, $6\frac{2}{3}$ per cent. per annum. On the other hand, motor vehicles built three years ago have recently changed hands at a quarter of their cost price, which is equivalent to depreciation at 25 per cent. per annum.

Makers having now had more experience, the depreciation of a new motor vehicle should not be so heavy, but the change from new to second-hand, produced by about a year's use, takes a great deal off the selling value of anything, and any system of depreciation should show a large amount written off the first year, and a decreasing amount in each of the succeeding years. The author considers that the only fair way to calculate the depreciation of a modern motor vehicle by one of the best makers, is to write off 25 per cent. the first year, and to write off in each of the succeeding years 25 per cent. of the value as reduced by the deduction of the depreciation. With

STANDARD FIVE-TON BREWER'S WAGON—BY THE STRAKER STEAM VEHICLE COMPANY, LTD.

TIMBER TRANSPORT COMPOUND TRACTION ENGINE—BY MESSRS. JOHN FOWLER AND CO., LTD., LEEDS—WITH SIX ORDINARY TIMBER TRUCKS IN TRANSIT.

TABULAR STATEMENT OF COST OF WORKING MOTOR LORRIES

Tons per journey	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten
Capital cost of motor wagon	£500	£537	£575	£612	£650	£687	£725	£762	£800
Ton-miles per day	30	41	52	63	75	86	97	108	120
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Wages	0 7 6	0 8 5	0 9 4	0 10 3	0 11 0	0 12 2	0 13 1	0 14 0	0 15 0
Fuel	0 5 0	0 5 0	0 5 0	0 5 0	0 5 0	0 5 6	0 6 0	0 6 9	0 7 6
Stores, oil, etc.	0 1 6	0 1 6	0 1 6	0 1 6	0 1 6	0 1 8	0 1 10	0 2 0	0 2 3
Repairs and renewals	0 7 6	0 7 6	0 7 6	0 7 6	0 7 6	0 7 9	0 8 3	0 9 0	0 10 0
Supervision	0 5 0	0 5 0	0 5 0	0 5 0	0 5 0	0 5 0	0 5 0	0 5 0	0 5 0
Interest on capital	0 2 1	0 2 3	0 2 [illegible]	0 2 7	0 2 9	0 2 11	0 3 0	0 3 2	0 3 4
Depreciation	0 10 5	0 11 2	0 11 11	0 12 9	0 13 6	0 14 4	0 15 1	0 15 10	0 16 8
Insurance	0 2 1	0 2 1	0 2 1	0 2 1	0 2 1	0 2 1	0 2 1	0 2 1	0 2 1
TOTAL . . £	2 1 1	2 2 11	2 4 9	2 6 8	2 9 7	2 11 4	2 14 1	2 17 10	3 1 10
Cost of same work with horses	1 0 0	1 7 6	1 15 0	2 2 6	2 10 0	2 17 6	3 5 0	3 12 6	4 0 0

interior works a higher percentage will have to be taken. This results in an inverted compound interest system, that writes off a large sum the first year, but still shows that the scrap has some value even after fifteen years' use.

WORKING COSTS AND STANDING CHARGES.

Subject to the remarks already made as to the difficulty of arriving at the exact value of the working costs and standing charges, the author has endeavoured, from his actual experience, and information kindly afforded by other users, to tabulate a statement of the average cost of working motor vehicles. In this table the cost has been worked out at per day, on the assumption that the motor is worked 240 days in the year, and that the working day is taken at ten hours.

Assuming, therefore, that one-third of the day will usually be occupied in loading and unloading, the ton-mileage is approximately arrived at, but it must not be forgotten how many indeterminate factors may affect this result. It is assumed that the return journeys will be made empty, or with empty bottles, boxes, casks or crates, so that the ton-miles can only be reckoned on the outward journey. If longer hours are worked, the fixed charges per ton-mile will be proportionately reduced, but the wages, fuel, stores, repairs and renewals, will always be proportionate to the ton-mileage for each size of wagon.

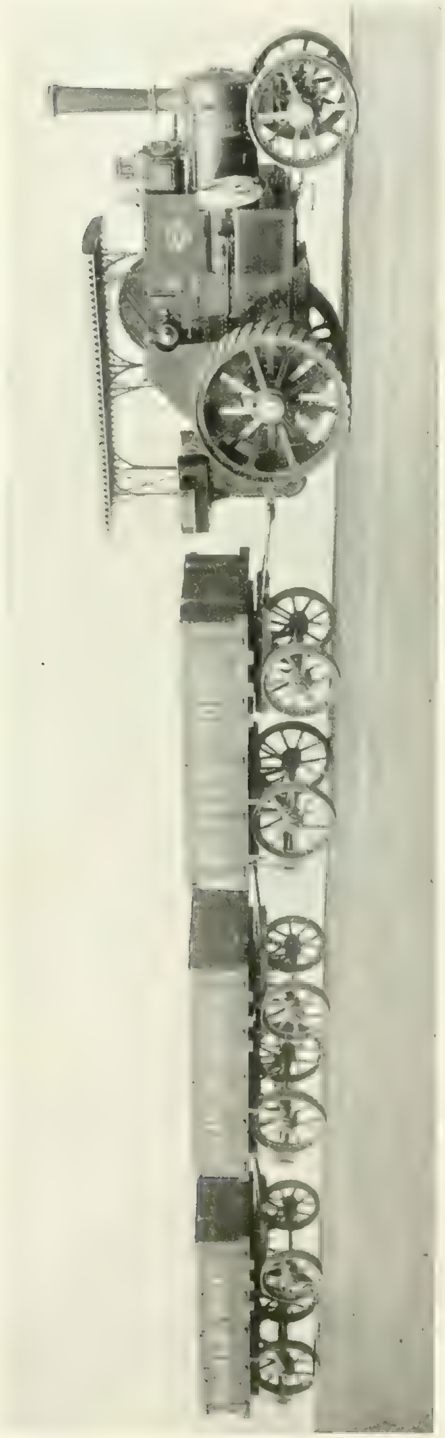
In the foregoing tabular statement, some items require a little explanation. It is presumed that the weight of the usual load being known, a motor will be bought designed to carry that load. If the load is under five tons, it is best to carry it all on the motor; if five tons or over, it is best to distribute it between the motor and a trailer, in the proportion of three to two. The cost of a trailer is therefore included with that of the wagon for loads of five tons and upwards.

The smaller vehicles can be worked with only one man, but an assistant is advisable in any case, and is a necessity with loads of five tons and over. The men will, of course, be employed on the Saturday, and perhaps at other times, in washing out the boiler, cleaning, overhauling, and repairing. The wages therefore, for the whole week must be divided over only five paying days. Interest at 5 per cent. is chargeable on the capital cost of the plant, and depreciation, as already explained, at 25 per cent. per annum. The depreciation gets less each year as the value of the plant decreases, but this is about counterbalanced by the increase in the cost of renewals.

It is very easy to lose sight of the small outgoings in repairs and renewals to lamps, suction hose, firing tools, brake fittings, etc. Experience proves that on an average one lamp per week is broken, though not always past repair. The author gathers all these together and includes them with repairs and renewals. It is assumed that the owner will insure his boiler, if a steam wagon: his men, against employers' liability; his wagon and trailer against fire; and his liability for third party damages. This, for the purpose of calculation, is taken at £25 per annum per wagon and trailer. No allowance has been made for rent or office charges, as these would be much the same whatever form of transport is employed.

From these figures it will be seen that the minimum load for profitable working is about five and a-half tons; but, as previously remarked, other considerations besides the comparison with horse haulage may have to be weighed. As in every business, the facilities for loading and unloading necessarily differ, the figures may have to be altered accordingly. Again, if return

loads can be arranged, the cost per ton mile can be halved, but the author's experience is that return loads, properly so called, not empties, can never be arranged in actual practice.



TRACTION ENGINE WITH WAGONS—BY MESSRS. J. AND H. MCLAREN, LEEDS.

ENGINEERING PROBLEMS PRESENTED BY MOTOR TRANSPORT.

It is not within the province of this paper to discuss the various makes of motor-lorries and their relative advantages and disadvantages, but motor transport still presents some very interesting problems for the solution of the mechanical engineer.

There are many debatable points that will only be settled on the Darwinian principle of the "survival of the fittest." These can merely be instanced in this paper, such as (*a*) three points of suspension *versus* four; (*b*) the type of boiler, locomotive, vertical fire-tube, water-tube, flash, semi-flash, or hybrids; (*c*) gear *versus* chain transmission; (*d*) spring driving; (*e*) the method of transmitting the tractive effort to the main frame. There are, however, two points which call for more detailed discussion, namely (A) road wheels, and (B) heavy oil motors.

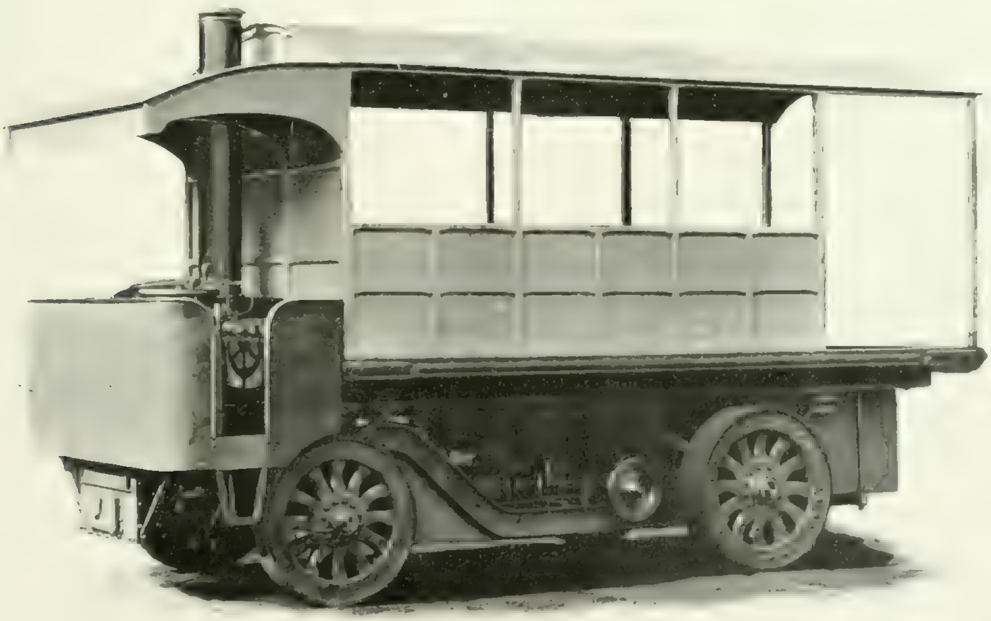
No wheel has yet been made that will stand for long the effect of motor transport. Wooden wheels, after a month's work, begin to open at the felloes, and though constantly tightened up at the hub they require to be replaced or entirely reconstructed after eighteen months' work. Built up steel wheels are used with either cast or forged hubs and spokes riveted to the rims, which are made of angle or tee irons. Wheels have also been tried with some success, made of two dished plates, with portions cut out to lighten them. All steel wheels require some form of tyre riveted to them, and it is only by constant attention to the rivets that these wheels are kept running.

The author has noticed that one firm of makers is now sending out wheels made like steam roller wheels, with cast hubs and rims, cast with the spokes in position. These are excellent whilst they last, but a broken spoke cannot be replaced and cannot be satisfactorily patched. Some motor lorries have recently been supplied to the War Office with cast steel wheels, the spokes being cast with the boss and rim, and these are run in the first instance without tyres. It remains to be seen how the spokes will stand the road work.

On paved streets the slipping of smooth-shod wheels, which have to propel the vehicle as well as carry the load, is very dangerous. The author has observed a motor-wagon on a granite paved London street swing round through an angle of 180 deg., by the slipping of the driving wheels. It can well be conceived how dangerous this is in crowded traffic. Therefore, when the ideal wheel is made it must have a tread that will not slip and yet will cause no more resistance to motion than does a smooth steel tyre. The author hopes to carry out some extensive experiments in this direction, and would always be pleased to afford opportunities for the trial of new wheels and tyres on his motor-wagons.

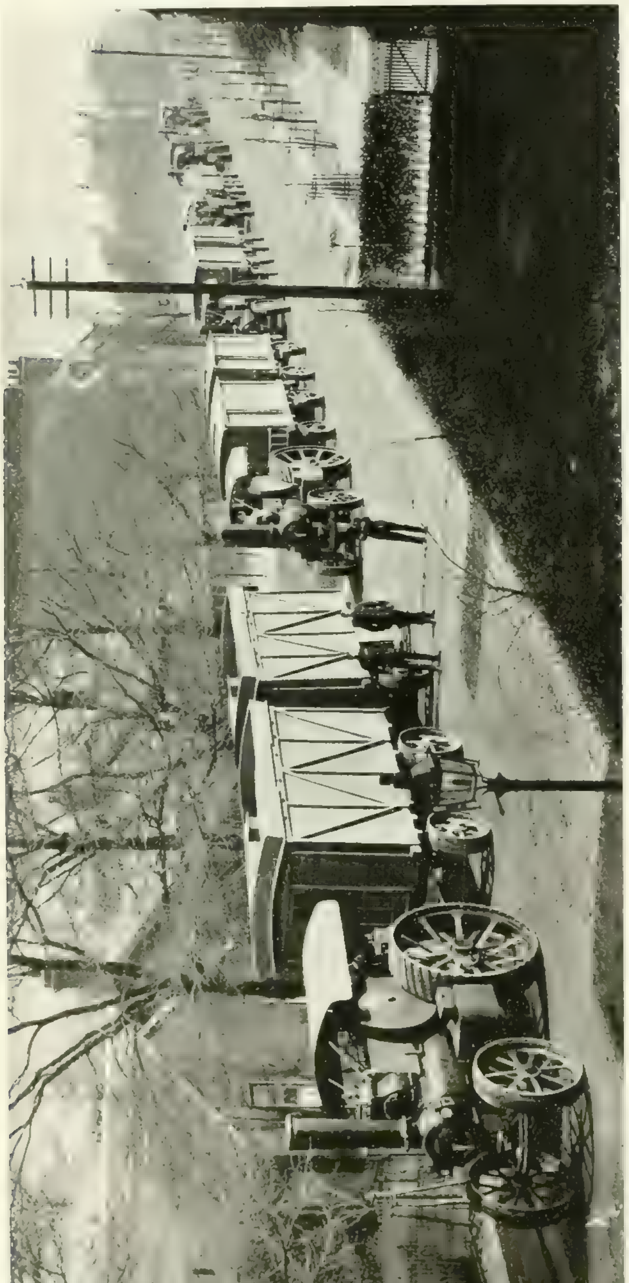
As regards heavy oil motors, there are so many advantages for motor work attached to the internal combustion engine, especially with the lighter loads, that it is only the cost of the spirit that militates against their use. There are obvious advantages in

FOUR-TON STEAM WAGON AT THE DELHI DURBAR—BUILT BY THE THORNYCROFT STEAM WAGON COMPANY, LTD., CHISWICK.



COKE-FIRED STEAM MOTOR WAGON—BY MESSRS. C. AND A. MUSKER, LTD., LIVERPOOL.

being able to start at any time, and not having to stop to raise steam. Consequently every one conversant with the needs of motor transport is looking for an internal combustion engine that will work with crude heavy oil instead of the expensive petrol. The success of the Hornsby and Diesel engines for stationary work shows that we are within a measurable distance of attaining our wish, but at the present time there is but one such motor on the market for road traction, and that does not appear to have emerged from the experimental state. Texas residue can be bought in bulk on the wharf at forty shillings per ton, which works out to twopence per gallon. If this is compared with the cost of petrol it will at once be seen what an enormous impetus motor transport would receive on the production of a practical and efficient internal combustion engine that would work on this oil and stand the trying conditions of road work.



MILITARY TRANSPORT TRAINS SUPPLIED TO H.M. WAR OFFICE BY MESSRS. JOHN FOWLER AND CO., LTD., LEEDS, FOR THE BOER WAR. CAPACITY, 120 TONS.

NEW REGULATIONS UNDER THE 1903 ACT.

The public will now await with some anxiety the regulations which the Local Government Board are empowered to make under the new Act. It is to be hoped, in the first place, that the maximum tare weight of motor vehicles will be raised to six tons, and that, in addition, a trailer of two tons tare will be permitted. With such a tare weight much more reliable vehicles could be made, as strength would not have to be sacrificed to lightness so ruthlessly. This would both reduce the liability to breakdown and the cost of upkeep. There would not be a proportionate increase in the weight carried, as the number of firms who require to send out over ten tons at a time to any one place is very few.

Elaborate and careful statistics as to the weight of consignments by rail shows that the average for the whole country is about 2 tons $7\frac{3}{4}$ cwts. This is evidence that few firms make such very weighty consignments. Further, a great deal of the opposition of the coal merchants of this country to the introduction of the large-capacity railway truck is probably due to the fact that ten tons is as much as even a coal merchant requires at one time of any one coal. In fact hardly any one is prepared to deal with larger consignments of anything than ten tons, and, therefore, that is likely to be the maximum consignment, no matter how lenient the regulations may be, but the extra tare weight is requisite to enable a more lasting and more reliable machine to be manufactured.

There is absolutely no necessity for any regulations as to the speed at which such heavy motor-wagons may travel. They are never wanted to travel at a greater speed than that of the loaded pair-horse van, and no maker or user would try to run them faster. On the other hand, when returning empty there is no justification for limiting them to five miles an hour, as if

[illegible] obstruction on the road and they would be more under control than any horse-drawn vehicle.

It is not only reasonable but necessary that such regulations should make obligatory a much wider tyre than that specified under the present regulations, and a larger diameter of wheel should also be made obligatory. The present motor wagons can never be trusted off the very hardest roads. The actual gross weight may not bear comparison with that of traction engines, but the concentrated pressure is greater, being carried on a much narrower wheel and one of much smaller diameter.

WEAR AND TEAR OF ROADS UNDER MOTOR TRANSPORT.

No statute, except section 28 of the 1878 Act, has hitherto dealt with the diameters of wheels for heavy traffic, and the subject has never received proper consideration. The author has often noticed, on a road that would be considered fairly hard, the road actually bend under traction engine traffic, and the engine or wagon wheel may be seen to be taking a bearing for a length of from 18 in. to 2 ft., or even more, the road springing up again after the wagon has passed. Under constant traffic of this nature, a flint, gravel, or limestone road is soon reduced to mud or dust, according to the weather, not by abrasion of the surface, as with ordinary horse traction, but by crushing and abrasion of one stone against another, as this concentrated load is applied and removed. Further, when the road yields thus, there is a shearing action at the edge of the tyre that helps to destroy the surface of the road. If there is no foundation, the wheels shear right through, and the wagon has to be jacked out. An increase of the width of the tyre would reduce this effect, but an increase of diameter would produce a much greater effect.

A year ago, having a traction engine working on a weak gravel road, the author made some careful measurements of the amount to which the wheels depressed the road. The engine weighed, with coal and water, 16 tons, of which 14 tons was carried on the driving wheels. These were 1 ft. 6 in. wide, and 7 ft. in diameter. Each wagon with its load weighed 12 tons, of which 6 tons were carried by each axle. The wagon wheels were 9 in. wide, and 3 ft. 6 in. and 4 ft. diameter respectively. At the first place measured, the engine depressed the road ½ in., and each truck wheel 1½ in. In another place the engine depressed the road 1 in., and the truck wheels 3 in. The pressure per inch width of tyre was respectively ·39 tons and ·33 tons. From this it will be obvious that the diameter has more effect than the width in preventing road damage.

Many county and district surveyors have, in conversation with the author, spoken of the destructive effect of repeated motor traffic on weak roads. There is a very simple remedy for this, namely, to make all the roads decently strong. Unless there is both [illegible] a really hard surface, this traffic soon shows effects. As no motor-wagon will pull through bad roads, either the driver finds another road round and proceeds to cut that up, or the owner lays stone on the road with no regard to the principles of road construction or of the results to any traffic but his own. More frequently the owner, who having his mill or factory in the village is one of the largest ratepayers, brings pressure on the Council to make up the road to a proper standard.

There is no doubt, however, that roads have to carry greater weights every day, and as these wagons have come to stay, all roads ought, as soon as is financially possible, to be made up to a proper standard. It is a disgrace to any district in this twentieth century to have a public road that is not strong enough to carry motor-wagon or traction-engine traffic. It is only fair to point out that if the road is made up to a proper standard, with a good foundation and hard crust, the wear produced by motor transport is less than with any other form of road locomotion. The hammering action of the horses' shoes is entirely absent, and the tearing action of the traction-engine driving wheels, pulling at the road to get a grip to draw forty tons behind it, is replaced by the rolling motion of the smooth motor wheels, which help to consolidate the road surface, and produce no abrasive action. Motor users are therefore justified in demanding hard well-made roads, urging with accuracy that the capital expenditure in thus making up the roads is more than counterbalanced by the reduction in upkeep.

SUMMARY.

[illegible] advantages of motor transport from the point of view of various users.

For small traders or retailers, or for those whose goods are sold in comparatively small parcels, the motor vehicle offers no economy, but is occasionally used as an advertisement.

For manufacturers whose goods are sent out in two to three-ton loads the motor vehicle offers a mode of transport that is quicker, though not more economical, than horses, and which offers a more certain delivery than rail.

A large contractor would find one or two motor-wagons very useful for weighty materials, but would have to bear in mind its several limitations. For instance, many goods are sent by barge up the Thames, and discharged overside at low water into carts standing on the shingly river bottom. No motor-wagon yet constructed would pull a paying load from such a situation, and up the steep slopes on to the road.

A road contractor, again, would find that the motor-wagon can do but little of his work, as except in a very dry summer, it could not be trusted into gravel pits, brickyards, or on to unmade roads, whilst it has not the power to pull over a rough ballasted road, where it would often be required to deliver its load.

Many steam wagons are now at work for brewing [illegible]

mineral water manufacturers can very rarely make up large enough consignments to single customers. Motor-wagons have been tried for rounds work, but so much time is lost delivering small quantities and hunting up empties, that a motor-wagon cannot deliver more in a working day (and the mineral water carter's working day is not far short of twenty-four hours) than could be handled by a pair of horses.

Flour is a very heavy material and handled in large parcels, and several motor-wagons are now engaged in this work. Cement is sometimes sent out in large enough parcels to justify the use of motor-wagons, but so much is sold a sack or two at a time, that it is difficult to keep the motor-wagon in constant work.

Without specifying the materials, it may safely be said that with heavy loads, five to ten tons, and short runs of two to four miles, the question of whether motor transport is more economical than horse transport entirely depends on whether the loading and unloading can be carried out with sufficient expedition. On the other hand, with light loads of from two to three tons, and long runs of from fifteen to thirty miles, the question of economy turns on whether there is competition with railway rates. For such loads the motor should be one of light tare, constructed for the loads in question, and able to run at a fair speed.

The ideal work for motor transport is where loads of from five to ten tons require to be constantly carried for ten or more miles. The word "constantly" is used advisedly, as the wagon body should be constructed specially to suit the particular trade, as taking a load of, say casks, on a body constructed for boxes, or broken granite on a flat platform lorry, is both costly and destructive.

For municipal work there are very few circumstances under which the motor-wagon can be used to advantage. For dust collecting an intelligent shire horse requires no more attention than an occasional word from one of the men, but if a motor is used an expensive driver must be employed to drive it from door to door. Again, street, market or house refuse all bulks large, and it is impossible to get more on a motor-wagon than two horses would take at the trot. Further, the runs are mostly short. For street watering the distance between hydrants is short, so that there is no advantage in being able to take more than a horse would pull. In Liverpool and Westminster the motor-wagons are worked twenty-four hours a day, but the author believes that, making proper allowance for depreciation, and charging correctly all repairs and wages, the work could be done cheaper and as efficiently by horses.

Many firms who have tried motor vehicles have given up their use from various causes. In some cases the loads and journeys were not such that a motor-wagon could be used to advantage. In many cases, however, the constant attention they require and the close professional supervision, or, failing this, the frequent breakdowns, have led to their rejection.

It would therefore seem that the better system is to contract with a firm to do the cartage required, with motor-wagons. Many manufacturers put all their carting out to contract, and find it the more satisfactory method. It is reasonable to suppose that an engineering firm, with its proper staff of overseers and foremen, and its own repairing workshops, would have a much better chance of conducting motor traffic with economy and dispatch. At the same time the trader would be relieved of this extraneous responsibility, and would be enabled to devote all his energies to the prosecution of his own legitimate business.

The author trusts that his views on the subject of motor transport will not be considered too pessimistic. He has endeavoured to set forth dispassionately the economic position of motor vehicles. The progress of mechanical science is constantly changing the economic conditions, and the circumstances of to-morrow may be widely different from the circumstances of to-day. Better engines, cheaper fuel, less legal restrictions, and the accumulating experience of engineers, will rapidly increase the range of useful employment for motor vehicles. No one regrets more than the author that motor transport is not, as some seem to think, the solution of all our social, moral, political, hygienic and economical difficulties.

Read before the Society of Engineers.

OUR MONTHLY BIOGRAPHY.

Mr. ROBERT A. HADFIELD, J.P., M.Inst.C.E.

MR. ROBERT A. HADFIELD, J.P., M.Inst.C.E., [illegible] distinguished himself in natural science and chemistry, and his pronounced taste for metallurgical pursuits was encouraged by his father, the late Mr. Robert Hadfield, who provided for his use a small melting furnace and

MR. ROBERT A. HADFIELD, J.P., M.INST.C.E.

other plant, by means of which he was able to carry out experiments at home. This no doubt served to inculcate that spirit of independent investigation which has been a pronounced feature of Mr. Hadfield's career.

On entering the Hecla Steel Works, founded and developed by his father, Mr. Hadfield devoted himself more particulary to laboratory work. The entire responsibility of managing these huge works, however, devolved upon him at an early age, and he has been Chairman and Managing Director of Hadfields Steel Foundry Company, Ltd., since its formation in 1888. The works of the company now cover an area of nearly ninety acres and give employment to about 4,000 workmen. [illegible] over 1,000 feet in length and has an area of nearly 300,000 square feet.

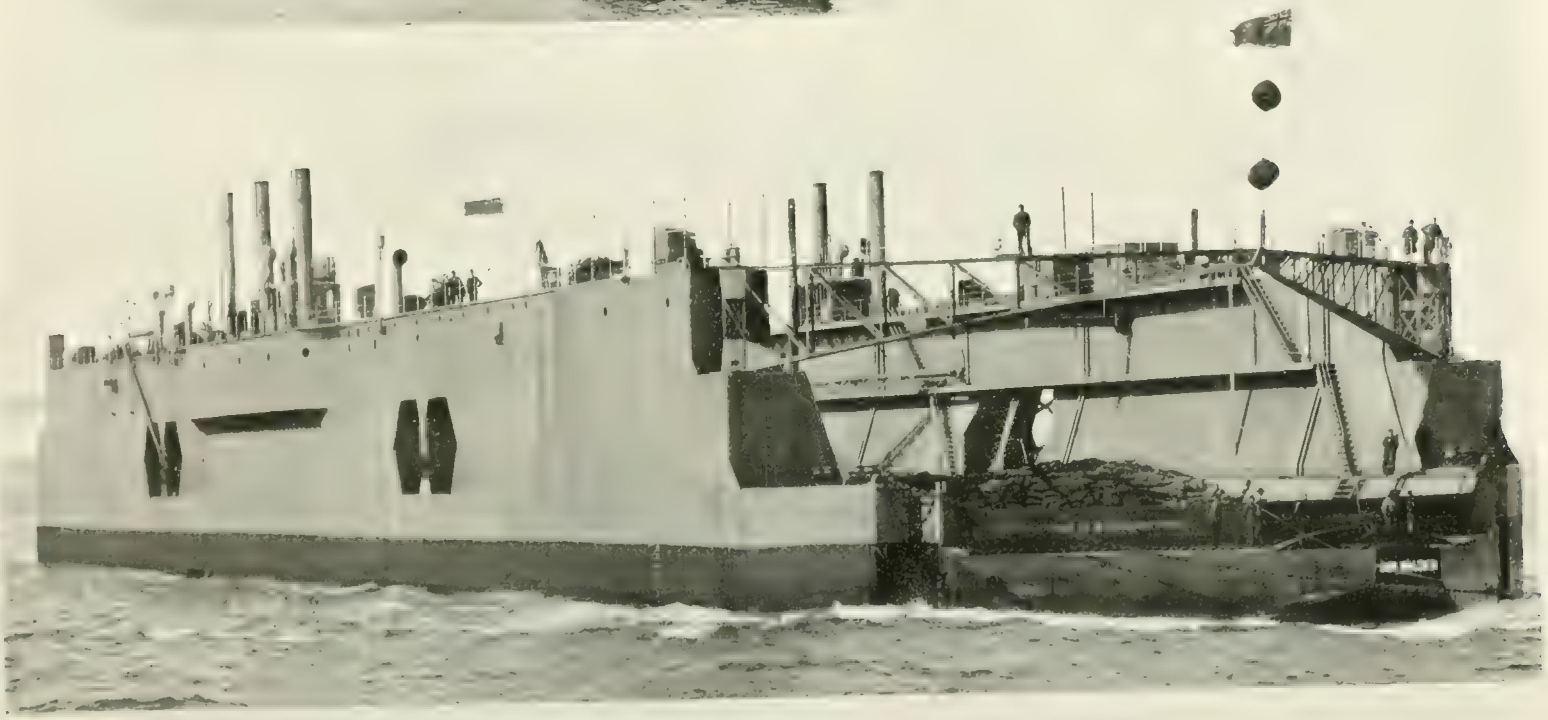
[illegible] tation for its projectiles. Within the last four years it has taken up the manufacture of special track work, and in this direction an important part has been played by Manganese steel. This material, the most valuable product and discovery of Mr. Hadfield's experimental work, is remarkable for its extreme hardness and great toughness.

Mr. Hadfield has been a constant contributor to the proceedings of the various learned societies, his paper on "Alloys of Iron and Manganese" being probably the first systematic alloy research work presented in this country or elsewhere. His paper on "Alloys of Iron and Nickel," read before the Institution of Civil Engineers in 1899, was characterised by Sir W. H. White, K.C.B., as not only research work of original merit but a most masterly summary of all that had been done in the world in that connection. His latest achievement, which will be still fresh in the memory of our readers, was a very complete study of the "Alloys of Iron and Tungsten," read at the recent meeting of the Iron and Steel Institute.

From the Institution of Civil Engineers Mr. Hadfield has received the George Stephenson Gold Medal and Premium, the Telford Medal and Premium, and last year he was awarded by the same Society the Howard Quinquennial Prize for his "scientific work in investigating the methods of treatment of alloys of steel, and on account of the importance to the industry of some of the new products introduced by him." Among previous recipients of this honour have been Sir Henry Bessemer, Sir William Siemens, and Sir Lowthian Bell. Other honours include two awards of Gold Medals from the Société d'Encouragement pour l'Industrie Nationale. Mr. Hadfield was Master Cutler for Sheffield for the year 1899-1900, and is at the present time a Vice-President of the Iron and Steel Institute. He is also on the roll of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and numerous other technical Societies.

The New Floating Dock for Durban.

The smaller illustration shows the new floating dock built by Messrs. Swan, Hunter, and Wigham Richardson, Ltd., for Durban, as she was being towed down the Tyne. The larger view of the dock was taken at sea. It is of the same type as that at H.M. dockyard at Bermuda, and is similar to its unfortunate predecessor which was wrecked on the way to Durban. The dock has a lifting power of 8,500 tons; its extreme length is 475 ft. and its width 96 ft. 2 in. There are in all forty-four watertight compartments. Two separate but identical installations of machinery for pumping, etc., are contained in the upper portion of the side walls.



THE NEW TYNE-BUILT FLOATING GRAVING DOCK ON ITS WAY TO DURBAN.

RAILWAY EXTENSIONS AND DEVELOPMENTS.

Widening the London and North-Western Railway at Euston.

The widening of the London and North-Western Railway, which is now in progress between Euston and Camden, is the natural result of a great development in traffic which has been in progress for some years. Not only has the number of trains arriving at and departing from Euston largely increased, but the composition of the trains has greatly altered, especially in the case of the heavy expresses to the north—the leading feature of the North-Western traffic. Long corridor trains, with elaborate dining saloons, sleeping cars and coaches, all of great length and weight, have taken the place of the lighter trains of former years, which are now chiefly used for local traffic, and with the increase in the number and length of trains, station accommodation had also to be increased, with the result that within the last twelve years Euston Station has been considerably enlarged. The number of platforms has been nearly doubled, while the approach to the station from the railway has been trebled in width, and with such additions at the terminus it was imperative that the lines leading into it should be increased also, and that greater facilities should be provided for dealing with the exacting requirements of modern traffic. The widening now in progress has been designed to meet these wants, and is in pursuance of a policy of development and improvement which it is hoped will contribute as much to the convenience of the travelling public as to the interests of the railway company.

In designing such a scheme three main objects had to be kept in view, viz.: (1) increased facilities for the rapid passage of trains approaching and leaving Euston; (2) the separation, as far as possible, of all extraneous traffic, such as shunting operations, empty coach trains and engines, from passenger lines; (3) providing ample accommodation, within easy reach of Euston, for the storage, cleaning and marshalling of passenger trains.

The first object will be attained by providing four lines for passenger traffic out of Euston, two up and two down. They will occupy much the same position as the four lines now in use, which pass through the well-known cutting of the old London and Birmingham railway between Euston and Camden, but owing to the exigencies of space, two of these have hitherto been used chiefly for engine traffic and storage purposes.

ENTRANCE TO NEW TUNNEL UNDER PARK STREET WITH THE MAIN LINES TO THE RIGHT.

One of the massive retaining walls is seen on the left.

The second and third objects have involved great changes in the surrounding neighbourhood. All the old landmarks have disappeared, the detached villas bordering Park Village East and Mornington Road have been swept away. The old curved

retaining walls are in course of demolition, streets and roads have been closed, two bridges have been demolished, and when the widening has been completed over half a million cubic yards of earthwork will have been removed, and the railway will have an additional area of nearly twelve acres. To enclose this space, massive retaining walls have been built 10 ft. to 13 ft. in thickness at the base, and 30 ft. to 40 ft. in height, a tunnel is in course of construction under Park Street, a large new bridge has been erected over the railway connecting up Mornington Road and Park Village East, and a new street has just been opened between the latter thoroughfare and Stanhope Street.

EXCAVATING ON THE SITE OF NEW CARRIAGE SHED.
The new bridge connecting Mornington Road and Park Village East is shown in the rear.

As regards the second object, an important element in traffic arrangements at a large terminus is the disposal of arrival trains after their passengers have been discharged. Hitherto, at Euston, such trains have mostly had to cross the departure lines to gain access to the down side. Under the new system arrival trains will pass out on the up side, leaving the main line a short distance from the station, and travelling over the widening on the same side, will dip down and pass under the four main lines by a very skew subway, emerging on the down side, and thence returning to the station or the carriage shed. Similarly, engines for Euston from the sheds at Camden will cross the Regent's Canal by a new bridge and travel over the new lines on the down side, through the tunnel under Park Street, and thence under the main lines by the subway to Euston.

For the third object a very extensive carriage shed will be erected on the down side, 800 ft. in length, and covering an area of nearly three acres, ample siding accommodation being also provided for the marshalling of trains; and on the up side a smaller carriage shed will be erected, 450 ft. in length, with the necessary sidings.

The difficulties of dealing with the intricate traffic of a large terminus will thus be reduced to a minimum, and the changes will also, no doubt, conduce to economy in working.

To complete the whole scheme, alterations will also be required at Chalk Farm for the purpose of separating the fast and slow traffic.

Electrification of North-Eastern Railway Local Lines.

Our illustration shows the coaches which are to be used on the electrically equipped branches of the North-Eastern Railway Company. A new era in the history of this enterprising company was reached on the seventy-eighth anniversary of the opening of the first steam passenger railway between Stockton and Darlington, when an experimental train, consisting of two motor coaches with a trailer sandwiched between was run on the three miles of Tyneside local line completed between Carville station and Percy Main Junction. The trials were entirely successful. The train showed itself capable of maintaining a speed of forty-five miles per hour, although it is only intended to run at an average speed of thirty miles per hour, and the power of acceleration was such as to enable the train to attain full speed within thirty-five seconds after starting from rest. The extra rail is carried at the side of the existing track, the current being picked up by a shoe. The power for these trials was obtained from the Neptune Bank Power Station of the Newcastle Electric Supply Company, but a new power station is under construction at Carville which will supply the current when the system is complete. For the accompanying photo we are indebted to Mr. Wilson Worsdell, chief mechanical engineer of the company.

Great Western Railway Motor Cars.

During the month an interesting experiment was inaugurated by the Great Western Railway Company

Railway Extensions and Developments.

[illegible] Valley between Chalford and Stonehouse. For a long time the necessity for some auxiliary to the ordinary service has been apparent on this route, which extends over about seven miles. The new cars will stop not only at the existing stations, but at intermediate points, such as level crossings. The company will thus provide for the needs of a great number of people who have to make short journeys in this thickly populated district, while at the same time avoiding the running of extra trains of the ordinary kind over distances so limited as to make them unremunerative. Should the experiment in the Stoud Valley prove successful, the company will probably extend the system, and may possibly establish a road motor service on similar lines to that which has lately been introduced in Cornwall.

The new motor-cars were designed and built in the Swindon works of the Great Western Company, under the direction of Mr. C. J. Churchward. They resemble somewhat the electric cars of the London County Council, without the roof seats, and are arranged internally much in the same style as the carriages of the Central London Railway, [illegible] long, [illegible] in. wide, and 8 ft. 2 in. high, inside measurement. They are carried on under-frames of steel, resting on two four-wheeled bogies, one of which carries the engine and boiler. Fifty-two passengers can be carried in each car, the seats being composed of woven wire, covered with plaited cane. Steam for the engines is supplied by a vertical tubular boiler (fire-tubes), 4 ft. 6 in. in diameter and 9 ft. 6 in. in height, situated in a compartment in one end of the car. The engines are placed underneath the vehicle, and the cylinders drive on to the trailing wheels of the bogie, which are coupled to the leading pair of wheels. The wheels are 3 ft. 8 in. in diameter, and, with the boiler working at 180 lb. pressure, the tractive force equals 8,483 lb. Water for the boiler is carried in a tank fixed under the car. The capacity is 450 gallons. The cars are lighted with gas.

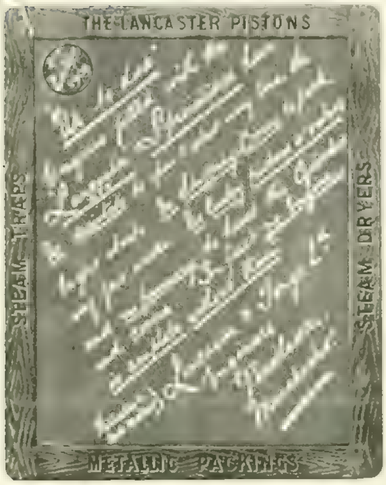
A Gigantic Siding Scheme.

The [illegible] North Eastern Railway Company have decided to erect a colossal siding for dealing with goods traffic at their Northallerton station on the main line from London to Edinburgh. The detail drawings provide for a siding which will be the largest in the world, and a model village of five hundred houses for the workmen to be employed in the shunting operations. This will act as a central collecting siding, and at which trains will be remade and despatched to all parts of the kingdom. The scheme is estimated to cost £520,000.'

ELECTRIC TRAIN ON THE LOCAL TYNESIDE LINES.

CATALOGUE DESIGN.

A great deal of ingenuity is expended in the compilation of modern catalogues, but frequently the exterior is stereotyped and ineffective. We purpose giving from time to time under this heading a brief account of conspicuous achievements in the design of catalogue covers.—Ed.



ONE of the most striking covers produced lately is the Slate of Messrs. Lancaster and Tonge, Ltd., which has already run through several editions. Here the aid of the three-colour process has been effectively employed. The design is simple, but it loses nothing in the execution. The slate has all the appearance of the scholastic apparatus, and while the idea is sufficiently novel to arrest attention, the white lettering is at once striking and can be read without trouble. In the top left-hand corner a perforation and cord play an important part in the realisation of the general effect. The back outside cover is the duplicate of the front. If we had been designing this catalogue, we should not have repeated the same wording on the back, but the slate, apart from its message, should prove an excellent business producer.

Messrs. Handyside's catalogue expresses originality in many ways, and is a complete and unique departure from the usual. The artist has evidently expended considerable pains in bringing out the due importance and value of each subject. The leading keynote, "Steel Work," dominates the whole picture in freedom and refreshing absence of conventionality. A symbolic bridge is shown below, spanning the universe, and the subjects—bridges, roofs, buildings, structures—attract attention in proper sequence. At the lower part of the cover these subjects are repeated in minor degree. For the design as an attempt to escape from the conventional, we have nothing but praise, and this production is fully in accordance with some of the catalogue covers and advertisements that have emanated from this firm. We think, however, that the headline, "Steel Work," might have been rendered more readable without any particular sacrifice of originality, while the word "Handyside" might with advantage have been thrown into greater relief.

THE TEACHING OF METALLURGY.

RECOMMENDATIONS OF THE LATE SIR W. C. ROBERTS AUSTEN, K.C.B.

J[illegible] teaching are [illegible] K.C.B., [illegible] the Teaching of Metallurgy. His important work, "An Introduction to the Study of Metallurgy," which has entered upon its fifth edition (revised and enlarged) within the past year, is so well known as to scarcely need description. Remarkable for its complete grasp of a complicated subject, it forms a fitting memorial of the author's labours in this field. It is widely regarded as a standard work from a master hand, and possesses a subtle touch which those who knew the writer remember affectionately. For the use of students a synopsis of contents is appended as a footnote.

The following passage sums up the author's opinions on the teaching of metallurgy :—

As the choice of a particular course of metallurgical study is of much importance to the student, it will be well to consider the various systems which have been adopted for teaching the subject.

First, there is the one that long prevailed in the Royal School of Mines of this country, which, from its founda-t[illegible] lectures and ordinary laboratory work, supplemented, since 1880, by visits to some metallurgical district.

Second, there is the system which receives its fullest development in the Berg-Academie at Freiberg, in Saxony, where the subject is studied theoretically in the lecture-room and laboratory, the main feature of the course being the attendance of the students, during a considerable portion of their time, in one or other of the celebrated works of the district in which the school is situated.

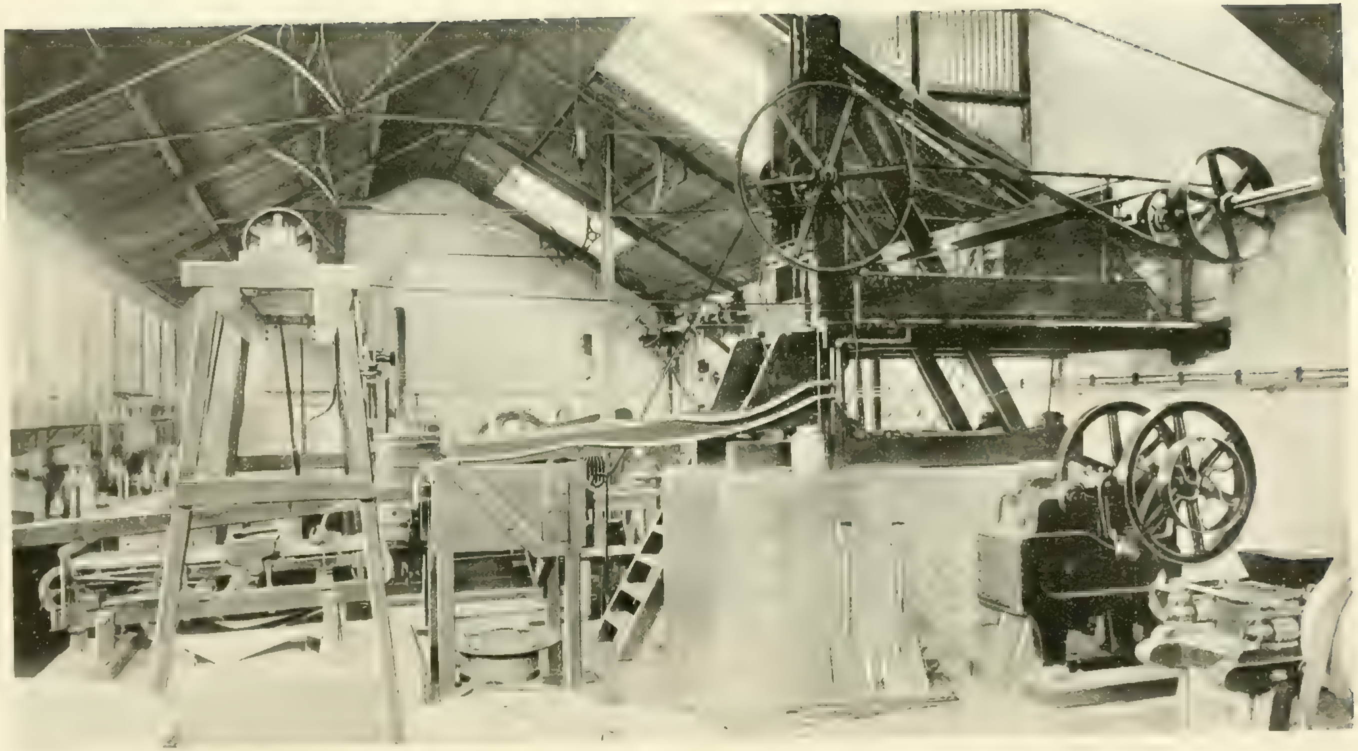
Third, there is the widely different plan adopted in certain American schools, notably in the School of Mines, Columbia College, New York, and at the Massachusetts Institute of Technology, Boston, where, in addition to lectures and laboratory work, the students actually conduct operations, often on a considerable scale, with small metallurgical plant

This is the system which the author unhesitatingly prefers, provided that the importance of laboratory work and research is not lost sight of. An industrial district is not, in his opinion, the best situation for the chief metallurgical and mining school of a nation. Such an institution derives great advantages from being placed in a metropolitan centre of education ; but, apart from the question as to locality, it may be urged that an attempt to derive practical knowledge mainly from ordinary metallurgical works is attended with very distinct disadvantages. It is difficult to bring home to young mining engineers the fact that failures in mines and works quite as often result from errors in judgment as from the poverty of the ores, or defects in the processes, and upon this point Prof. R. H. Richards,* of Boston, well observes that the great advantage of teaching students by the aid of small metallurgical plant consists in their "finding out by their own experience that little losses taking place everywhere in the course of their work mount up enormously in their final account of stock, . . . large works cannot afford to spoil a furnace-charge to show a student what happens from a little carelessness, and a well-regulated establishment may go on a long time without such a slip, and a student may be months at a works without finding out what is the key to its successes." At the School of Mines, Royal College of Science, this system of teaching with the aid of small plant is gradually being adopted, and there can be no question that the actual use of such appliances is most advantageous to the student, and that it enables him to acquire a better idea of the relations of metallurgical art to the sciences than is possible from mere theoretical work. As a type of such appliances the illustration shows a three-head stamp battery, Frue vanner, Blake crusher, and Krom rolls. Three cyaniding vats, 3 ft. 6 in. in diameter, are shown in the immediate foreground.

The total height of the stamps is about 12 ft., and they are capable of treating from 1½ to 2 tons of material in the course of a day. By the aid of this plant it is easy to determine what is the most effective speed to give to the stamps when working upon ores of various hardnesses and composition. A wide range of problems connected with the concentration of minerals may be studied, and considerable insight may be obtained into the difficulties of collecting the precious metals by amalgamated metallic plates. The degree of success of each operation is, of course, controlled by the results of assays.

This system of teaching with the aid of small plant is gradually being adopted by the author, whose laboratory at the School of Mines is already fairly well equipped. It is not, of course, urged that such a metallurgical laboratory would in any sense be a substitute for the works in which alone the professional education of a metallurgist can be fully developed, and no such claim is made on behalf of the engineering laboratories of which the country now possesses so many. Their success

* Trans. Amer. Inst. Min. Eng., Vol. VI., 1887, p. 150.



From "An Introduction to the Study of Metallurgy."]

A PORTION OF THE METALLURGICAL LABORATORY AT THE ROYAL SCHOOL OF MINES.

abundantly justifies their existence, and all the arguments which have been urged in favour of the kind of training they afford, may be applied to mining and metallurgical laboratories.

It is to be hoped that the growth of such laboratories will be fostered in this country.

Synopsis of Contents: The relation of metallurgy to chemistry—Physical properties of metals—Alloys—Thermal treatment of metals—Fuel and thermal measurements—Materials and products of metallurgical processes—Furnaces—Means of supplying air to furnaces—Thermo-chemistry—Typical metallurgical processes—Micro-structure of metals and alloys—Economic considerations—Appendix (Products in the Iron and Steel Industries). The subject is treated as a whole, the author giving no minute descriptions of processes, but choosing typical appliances and indicating their use in connection with groups of metals. Published by Charles Griffin and Co., Ltd. 18s.

Here Are Some Facts

ABOUT THE FOREIGN CIRCULATION

OF

PAGE'S MAGAZINE

Accompanied by a Chartered Accountant's Certificate.

[AUDITOR'S CERTIFICATE.]

80, COLEMAN STREET,
LONDON, E.C.,
October 17th, 1903.

Gentlemen,

I have examined the subscription books of PAGE'S MAGAZINE, and hereby certify that a copy of the magazine is paid for by, and despatched each month through the post to, yearly subscribers in the towns on the following list. This list does not include the magazines which are handed in bulk to the wholesale export houses in London for sale through the trade abroad, or forwarded direct to foreign agents, or the magazines circulated by the usual distributing agencies in the British Colonies and in foreign countries.

Yours faithfully,

JAMES F. VERNON,
Chartered Accountant.

"PAGE'S MAGAZINE" is sent each month to yearly subscribers in the following COUNTRIES and TOWNS direct from Clun House, the number of subscribers in each town varying in the majority of cases from fifteen to one hundred and fifty.

[The Magazines supplied through Wholesale Export Newsagents and Booksellers, &c., &c., are NOT included.]

Argentina—

Buenos Ayres
Mendoza
Puerto Militar
Rosario de Santa Fé
San Martin

Asia Minor—

Smyrna

Austria-Hungary—

Tyrol

Belgium—

Antwerp
Brussels
Haudeng-Goegnies
Kattendyke
Raevels

Bermuda

Bolivia—

Cupiza

Brazil—

Bahia
Minas-Geraes
Pernambuco
Rio de Janeiro

British Columbia—

Vancouver

British North Borneo—

Jesselton
Sandakan
Sarawak

California—

San Diego
San Francisco

Canada—

Collingwood
Montreal
Nova Scotia
Ontario
Port Hammond
Toronto

Cape Colony—

Cape Town
Cradock
Grahamstown
Kimberley
Mossel Bay
Winburg

Ceylon—

Colombo

Chili—

Caleta Buena
Carrizal Alto
Iquique
Valparaiso

China—

Hong-Kong
Shanghai
Soochow
Tangku

Colombia—

Itaqui
Panama
Puerto Berrio

Colorado—

Victor

Connecticut—

Hartford

Denmark—

Copenhagen

Egypt—

Alexandria
Cairo
Mansurah
Sohag

France—

Hautes
Le Vesinet
Marseilles
Paris
St. Lazare
St. Quintin
St. Raphael

Germany—

Berlin
Coblentz
Duisburg
Freiberg
Hamburg
Hettstädt
Kalk
Kiel
Mulheim
Strasburg
Tegel
Weisbaden

Gibraltar

Greece—

Lamia

Illinois—

Chicago
Peru

India—

Ahmadabad
Allahabad
Balaghat
Bangalore
Barrackpur
Bombay
Calcutta
Cawnpore
Chapra
Garbham
Hubli
Jubbulpore
Kapurthala
Karachi
Khatmandu
Kilpauk
Kurnuegala
Larkhana
Lucknow
Madras
Marikuppam
Midnapore
Munan
Naina Tal
Oorgaum
Quetta
Rangoon
Rosa
Umaria

Italy—

Florence
Genoa
Liguria
Leghorn
Milan
Monteroni
Naples
Palermo
Torcano
Turin

Japan—

Hiroshima Ken
Kyoto Fu
Nagasaki
Osaka
Sapporo Hokkaido
Tokio
Tsushima
Yokohama

Malay States—

Ipoh
Kuala Kangsai
Pahang

Malta

Maritius—

Curepipe

Massachusetts—

Boston
Buffalo
Lynn
Rockfort

Matabeleland—

Belingawe

Mexico—

Guanajuato
Mexico
Colima Cruz

Michigan—

Dollar Bay

Minneapolis—

Minnesota

Montana—

Butte

Natal—

Durban
Elandslaagte
Pietermaritzburg

Netherlands—

Amsterdam
Zandvoort

New South Wales—

Broken Hill
Reno
Sydney
Yass

New York—

New York
Poughkeepsie
Schenectady
Stapleton

New Zealand—

Auckland
Christchurch
Komata
Nelson
Reefton
Taranaki
Wellington

Norway —

Christiania
Christiansand
Porsgrund
Stavanger

Ohio—

Akron

Pennsylvania—

Chester
Philadelphia
Pittsburg
Scranton

Peru—

Arequipa
Huacho
Tuyillo

Philippine Islands—

Manilla

Portugal—

Lisbon
Oporto

Queensland

Brisbane
Ravenswood

Rhode Island—

Providence

Rhodesia—

Bulawayo
Gwanda
Gwelo
Hartley
Mozoe
Salisbury
Umtali

Russia—

Baku
Balaskinsky
Batoum
Ekaterinburg
Kama
Lodz
Odessa
Rostov
Sebastopol
St. Petersburg

Siam—

Bangkok
Puket

South Australia—

Adelaide

Spain—

Aguilas
Bilbao
Cartagena
Cindadreal
Cordova
Gijon
Madrid

Straits Settlements—

Penang
Sembilan
Singapore
Perak

Sweden—

Avesta
Eskilstuna
Nynashamn
Stockholm
Storfors

Switzerland—

Salvan
Zurich

Tasmania—

Beaconsfield
Magnet

Transvaal—

Benoni
Cleveland
Doornfontein
Florida
Turkey
Constantinople
Germiston
Heidelberg
Johannesburg
Krugersdorp
Liupaards Vlei
Pilgrim's Rest
Pretoria
Randfontein

Turkey—

Constantinople

Victoria—

Melbourne
Yarra

Washington—

Seattle
Tacoma

West Africa—

Sekondi

West Australia—

Coolgardie
Fremantle
Kalgoorlie
Kanowna
Kookyne
Mount Morgans

West Indies—

Antigua
Barbadoes
Cuba
Kingston

Wisconsin—

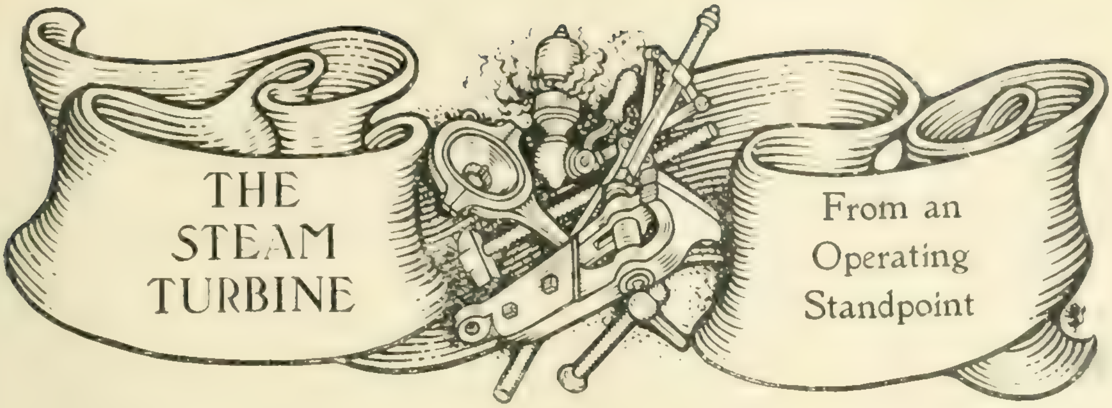
Madison

Yukon Territories—

Dawson City

Zululand—

Konohla



BY

FREDERICK A. WALDRON.

*The steam turbine here described is the first one of its size (except those operated by the builders) to be put into practical operation in the United States. The writer gives an account of its installation and operation, and includes data relating to a number of tests.—*ED.

IN the early part of 1901 it was decided to install a Westinghouse-Parsons steam turbine at the works of the Yale and Towne Manufacturing Company, of Stamford, Conn., after a thorough investigation made by the writer—and for the following reasons :—

(1) Floor space.

(2) Economy.

(3) Continuous operation of existing plant during installation of the new. (See fig. 1, power-house, building No. 13.)

The problem was, therefore, to concentrate the largest amount of power in the smallest possible area consistent with economical operation.

GENERATING OUTFIT.

The generating outfit consists of a two-phase 240-volt alternator, of 400 kilowatts capacity (when the turbine was running condensing, and the power factor of the alternator was from 90 to 100 per cent.), 7,200 alternations, running at 3,600 revolutions per minute, with a separate, direct-connected exciter set. The alternator is of the revolving field type, and the surface speed of the field is 22,137 ft. per minute. The weight of the outfit is 33,200 lb., and occupies a floor space 19 ft. by 4½ ft. (See fig. 5.) The guaranteed economy was 16½ lb. of water per electrical horse-power at the switchboard, with 28 in. of vacuum, 40 deg. F. superheat, and 155 lb. gauge pressure. Tests for economy, under slightly different conditions, show how nearly the guarantee was reached. This opens the question of what is the average ratio between an indicated horse-power at the engine and an electrical horse-power at the switch-board.

The electrical end of the machine is not compounded, and the variation in voltage depends entirely, within certain limits, upon the load and position of rheostats. Speed regulation is very close and perfectly satisfactory. A true kilowatt overload of 33⅓ per cent. has been carried for five consecutive hours, without apparent injury to the machine. Owing to the low-power factor, however, the heat developed in the field and terminals was much higher than is allowable in good practice. When thus overloaded, the volt meter had to be closely watched, in order to care for any suddenly applied load with the rheostat.

STEAM GENERATING PLANT.

At present the condenser plant consists of a surface condenser, containing 1,100 square feet of cooling surface, with independent air and circulating pumps. The air-pump is of the simplex, twin beam, vertical type, making about ninety single strokes per minute. The average vacuum obtained with this outfit, with plenty of circulating water, is about 27·4 in. This outfit is to be replaced by one of more recent design, and operated on the "dry system" and with a two-stage vacuum pump.

Steam is furnished by eight Manning boilers. The general arrangement of boiler and power-house, with its auxiliaries, is shown in figs. 2, 3, 4, and 5.

MOTORS.

Sixty-four induction motors (with varying loads), ranging from ½ to 40 h.p., are distributed throughout the works. (Fig. 1.) With the exception of the elevator motors, the entire plant is arranged on the group system. Wherever one or more machines are to be driven, belting or gearing is used, and, if room will permit, belting is given the preference, for the following reasons :—

(*a*) Flexibility.

(*b*) Less wear and tear on the motors.

(*c*) Absolute independence of speed of line shafts.

(*d*) Convenience in case of repairs.

In connection with this article it may be of interest to note that a second edition of Mr. Robert M. Neilson's work, entitled "The Steam Turbine," has been published by Messrs. Longmans, Green and Co. Price 10s. 6d. net.

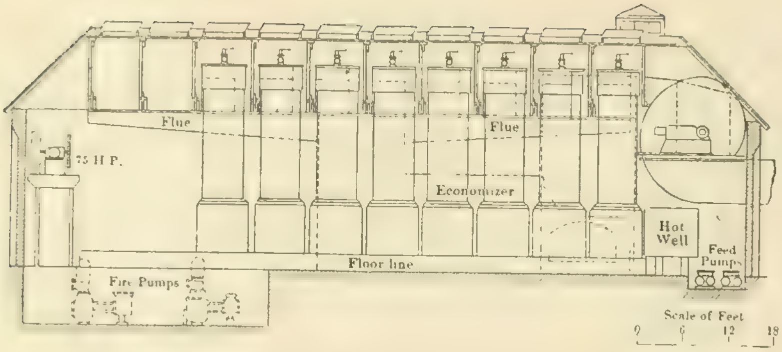


FIG. 3. LONGITUDINAL ELEVATION AND SECTION OF BOILER-HOUSE.

Owing to manufacturing requirements, it is found necessary to run the shafting both lengthwise and crosswise with the building. For example, buildings Nos. 1, 2, 4 and 10 have shafting running in both directions. The electric system of transmission lends itself admirably to this condition. Had this factory been one continuous building of from two to four stories high, with the power-house centrally located, shafting running in one direction, and light machinery installed along its line continuously, the question of the economy of electric transmission would have been doubtful.

(*e*) The advantage of changing, in event of increase or decrease of power requirements.

(*f*) Equal, if not higher efficiency, under continuous working conditions.

With this arrangement the power factor will range from 82 to 86 per cent., depending on the motor loads. The only precaution to take, in order to prevent frequent shut-downs with the induction motor, is to have the main circuits fused heavy enough to withstand the influx of current to the line, due to starting. By referring to fig. 1, the adaptability of electric transmission to a plant of this character is readily shown, without further explanation. There are, however, a number of conditions governing the installation that cannot be shown in the plans, a few of which are as follows :—

The iron foundry (building No. 24) which is situated about 700 ft. from the power-house, requires, from 7 a.m. until 12 noon, an average of about 7 h.p., and from 3 to 5.15 p.m., about 35 h.p.

Building No. 23 (which is an auxiliary to the iron foundry) requires from 25 h.p. to 30 h.p. to drive the tumbling barrels and grinders. When the blast is turned on to the cupola, in the afternoon, this motor is shut off, as the help is used in the foundry.

The requirements for power in building No. 25 demand 5 h.p. about one-half the time.

The box shop (No. 26) is situated about 1,000 ft. from the power-house, the nearest line shaft being about 300 ft. away from it. A 5-h.p. motor is used for about three hours a day, at this point.

The plating room, fifth floor (building No. 4), uses from 45 h.p. to 50 h.p., five hours per day, and 8 h.p. to 10 h.p. for the remaining five hours.

THE TURBINE AND ITS GENERATOR.

The turbine end of this machine has received very little attention in the past year, and has required no renewals or repairs to any of its parts ; in fact, from an operating standpoint, it is almost fool-proof. It was found necessary, when assembling the machine over a year ago, to remove from the bearings, with a fine oil-stone, some burrs which had been thrown up in handling, and also a little rust which had accumulated ; upon examination of the same, one year later, these marks had not been worn out, and there was absolutely no difference in the recorded diameters of the bearings covering a period of one year's wear.

Occasional longitudinal adjustment, to check the clearance between the blades in the case and the revolving element, is necessary. The wear and tear on other parts of the machine have been practically nil, and if the oil is kept in constant circulation and properly cooled, there is no need of a "hot box," and the amount of oil used is extremely small ; the consumption of this particular machine being half a gallon of cylinder oil per week, and from 3 to 5 per cent. of the lubricating oil on the bearings may be said to be wasted.

The principal trouble with the steam end is its liability to shut down, when running from three-quarters to

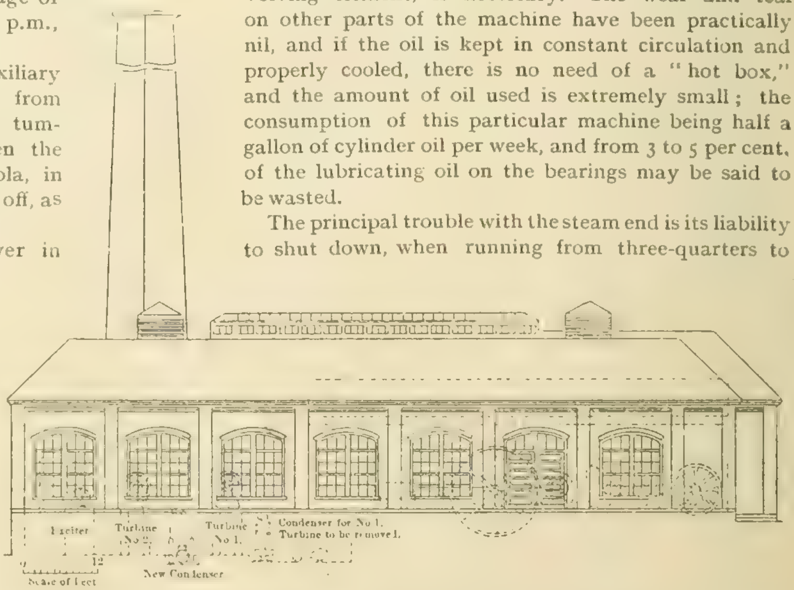


FIG. 4. LONGITUDINAL ELEVATION OF POWER-HOUSE.

A 350-h.p. cross-compound engine, and a 150-h.p. air compressor are shown to the right, with the two turbines and accessories to the left.

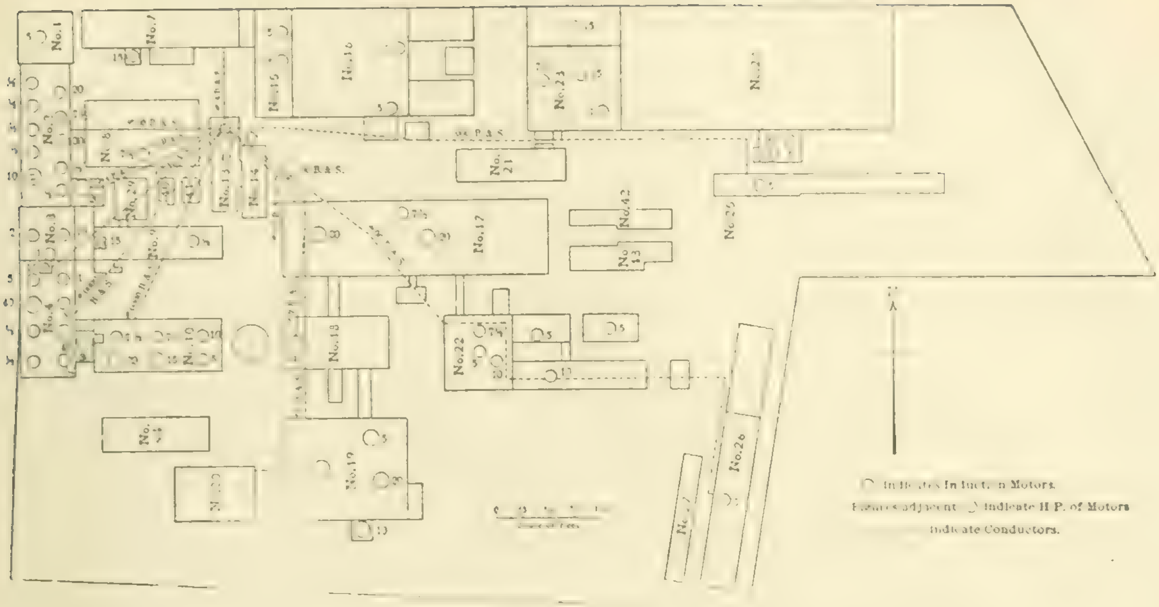


FIG. 1. GENERAL PLAN OF THE WORKS.

The size and location of motors are shown by small circles, and their horse-power is indicated by small figures, adjacent to circles. The numbers of the buildings are also placed upon them, as referred to in the text. Total nominal horse-power of motors, 660 h.p.

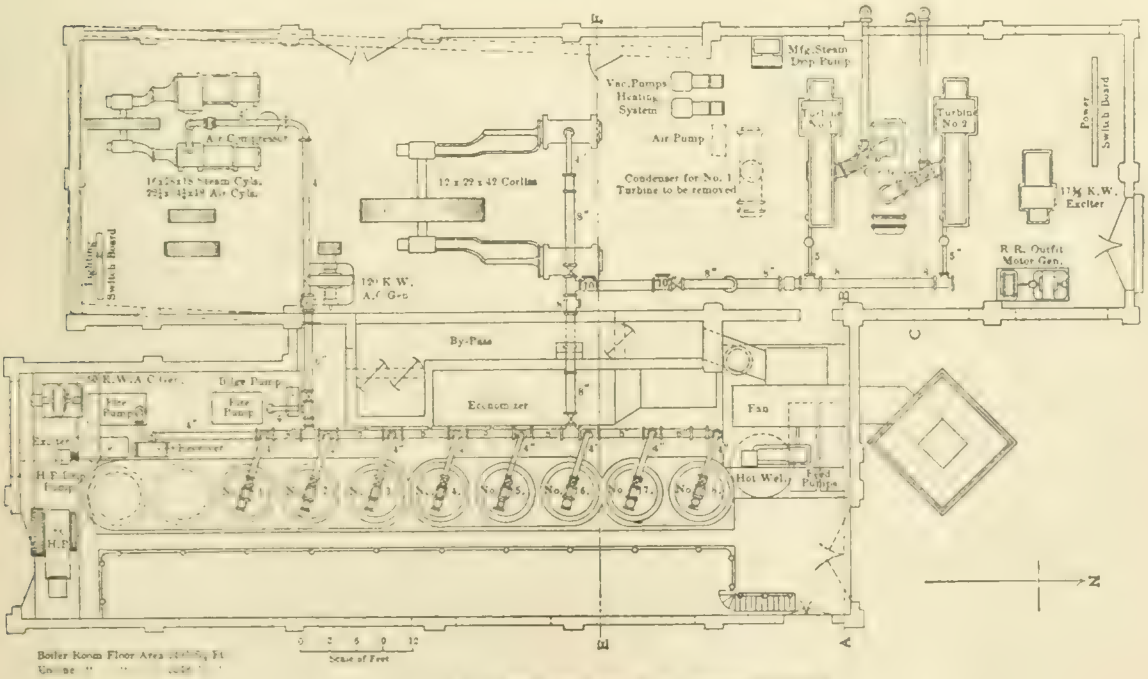


FIG. 2. PLAN OF THE BOILER AND POWER-HOUSE.

The two turbines are shown in place, with their condenser connections. Turbine No. 1 is the subject of this article. Turbine No. 2 is in course of construction. The exciter outfit is shown to the right of turbine No. 2, and is of sufficient capacity to care for both turbines. By removing the switch-board to a gallery (which can be readily constructed), another turbine could easily be placed in this room.

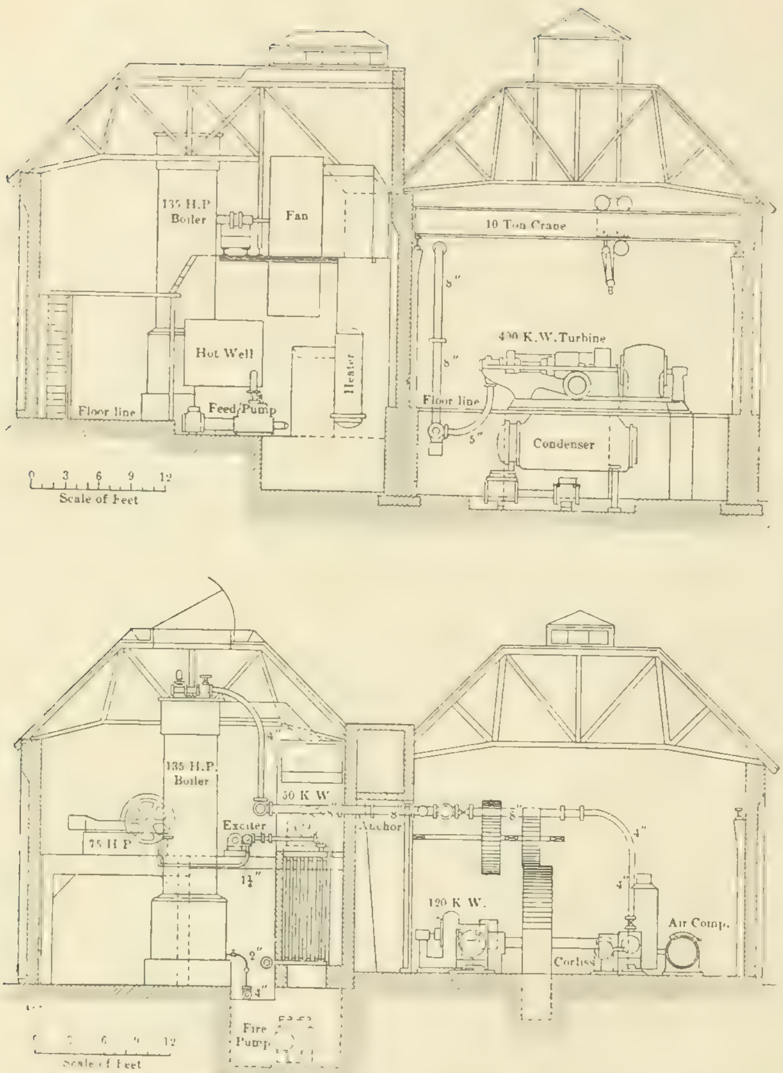


FIG. 5. SECTIONAL ELEVATION OF POWER AND BOILER-HOUSES.

full load, because the vacuum is destroyed. This can be prevented, if the engineer is on hand, but sometimes he is not, and we have had one or two shut-downs in the last year from this cause. I am informed, however, that a device for automatically preventing this is being designed by the makers, and we expect to have it on our second machine.

It is desirable to place in the pipe for cooling water for the oil well an eel-trap with a by-pass, and, what is still better, if convenient, to have two sources of water supply. An open drip should also be provided, which can be frequently tried by the engineer, to insure proper circulation of cooling water. The electrical end of the machine has given us *all* the trouble—not from the result of electrical design and defect, but from mechanical defects, pure and simple.

The field or revolving element is made of four cylindrical forgings, $23\frac{3}{8}$ in. in diameter, aggregating in length about 28 in. These sections are forced on to a shafting, with about 150 tons pressure.

TESTS.

The analysis of a number of tests made by the author indicate that, with the turbo-generator driving induction motors, and with an evaporation of 8·707 lb. of water per pound of coal, a brake horse-power can be delivered from the pulley of the motor for about $2\frac{1}{2}$ lb. of coal with a turbine of this size running under average economy. (This allows 5 per cent. for banking.)

Under the same evaporative conditions, the average non-condensing engines, distributed through the different rooms in the plant, would require 7·5 lb. of coal per brake horse-power at the fly-wheel, or three times that quantity required for the electrical drive.

One of the interesting questions answered by these tests is the small amount of power actually used in removing stock, in light manufacturing work.

In conclusion, the results obtained from this outfit may not be any higher than many obtained by direct connected sets of the same size, running under maximum economical conditions. Assuming that they are the same, the advantages of initial investment, constant economy and the possible extension of the plant with the turbo-generator outfit, are of sufficient importance to warrant the installation.

The strongest appeal, however, that the turbo-generator makes to the business man or the engineer is its inherent commercial efficiency. By this I mean that its efficiency is unchanged, week in and week out; year in and year out. Leaky pistons or valves, lack of alignment of slides and bearings, keying up, and, above all, lubrication, all of which exist in the reciprocating engine, are eliminated in the turbine.

Read at a recent meeting of the American Society of Mechanical Engineers.

SKETCH MAP SHOWING THE DIFFERENT SECTIONS OF THE GLASGOW MAIN DRAINAGE SCHEME.

THE GLASGOW MAIN DRAINAGE SYSTEM.

BY

BENJAMIN TAYLOR, F.R.G.S.

A short history of the project and an account of the works now in hand.—Ed.

If Cologne has the reputation of being the most malodorous of European cities, the Clyde has the reputation of being the most malodorous of European rivers. There are, perhaps, more evil smelling streams somewhere. The condition of the waterway is something of which the citizens of Glasgow are certainly not proud. They are not the only offenders, for many towns and a vast industrial area drain into what was once a pellucid salmon stream, but they are the greatest sinners, and for years past they have been endeavouring to exhibit their repentance in practical reform. They have resolved that the Clyde shall be an open common sewer no longer than the time requisite for the completion of the largest drainage operations ever planned—except those of London. When these operations are complete, and the waters of the Clyde cease to be polluted with the sewage of Glasgow, then all the communities, collieries, factories and urban areas in the Clyde valley will be called upon to refrain from pollution also. Thus Glasgow is not only busy with a great work, but is also bent on setting a great example.

The main drainage scheme for the collection and treatment of the sewage of Glasgow and the adjacent Local Authorities was authorised by special statutes in 1891, 1896, 1898 and 1901. The territory included stretches along both sides of the River Clyde for a distance of about fifteen miles, the superficial extent of the drainage area being about forty square miles. This territory may be increased by the inclusion of areas belonging to outlying authorities.

DRAINAGE AREA.

The drainage area is divided into three sections, each distinct from the others, with separate works for the disposal of their sewage. The first of these, authorised in 1891, and doubled in extent in 1901, comprises about eleven square miles, one-half within the northern portion of the city, and the remainder in the landward district of the county of Lanark. The works for the treatment and disposal of the sewage of this area are situated at Dalmarnock, in the east end of Glasgow, and the drainage is collected and conveyed there by a main sewer, constructed at the cost of the Caledonian Railway Company.

The second section was authorised in 1896, and includes that part of the municipal area on the north side of the river which was not provided for in 1891, the adjoining burghs of Partick and Clydebank, and intervening parts of the counties of Renfrew and Dumbarton—the whole extent being fourteen square miles. The works for the disposal of the sewage derived from this area are in process of construction on the river bank at Dalmuir, about seven miles below

Glasgow, towards the sea, say about halfway between Glasgow and Dumbarton.

The third section, authorised in 1898, comprises the whole of the municipal area on the south bank of the river, the adjoining burghs of Rutherglen, Pollokshaws, Kinning Park and Govan, and various extra-mural residential and rural districts in the counties of Lanark and Renfrew. The extent of this section is fourteen square miles, and it may be enlarged by the inclusion of the burghs of Paisley and Renfrew. The works for the disposal of the sewage of this area are to be located on the river bank at Braehead, about one mile eastward from Renfrew, the Royal riverside burgh which gives a title to the Prince of Wales.

The collecting and intercepting sewers which connect with the Dalmarnock Works in the first section have all been constructed, and have been in successful operation since May, 1894. The daily volume of dry-weather sewage treated there at present is about 16,000,000 gallons, which will ultimately be increased to 20,000,000 gallons.

The volume of dry-weather sewage to be ultimately treated at Dalmuir, in the second section, is 49,000,000 gallons; and the corresponding volume at Braehead, in the third section, will be 48,000,000 gallons.

For the complete collection and disposal of the sewage within this divided territory there will be thirty miles of sewers, varying in size from 2 ft. 6 in. in diameter to 10 ft., the separate capacities of which have been calculated to discharge, in addition to the daily dry-weather flow of sewage, an amount of rainfall equivalent to one quarter of an inch per day, or 214,000,000 gallons of combined discharge.

THE WESTERN SCHEME.

The principal features of the western scheme, or second section, now in progress, are the construction of an outfall sewer to convey the drainage of the higher levels of Glasgow and Partick to the works at Dalmuir; the construction of an intercepting sewer to collect the drainage of the lower levels of the city; the construction of an intercepting sewer to collect the drainage of the lower levels of the burgh of Partick; and a third intercepting sewer to convey to the Dalmuir Works the drainage of the burgh of Clydebank.

The Glasgow and Partick intercepting sewers are pumped into the outfall sewer at Partick Bridge on the municipal outskirts of the city, the lift of which is 37 ft. The pumping engines, three in number, are of the triple-expansion type, with plunger pumps, each being capable of raising 11,250 gallons per minute, or 16,000,000 gallons per day. Steam is supplied to these engines by four boilers, working at a pressure of 160 lb. per square inch. The Clydebank intercepting sewer is pumped at Dalmuir, the lift there being 21 ft. The smaller engines at Dalmuir are of the centrifugal type, and the power for the treatment plant is transmitted by electricity.

More than one-half of the total sewage of the western scheme is being carried to the Dalmuir Works, where the whole contents of the outfall sewer are delivered into precipitation tanks above tidal level. The purified effluent from the tanks passes by gravitation over a discharge weir into the river, and the sludge is pumped into specially constructed barges and conveyed to sea.

THE SOUTH BANK DRAINAGE.

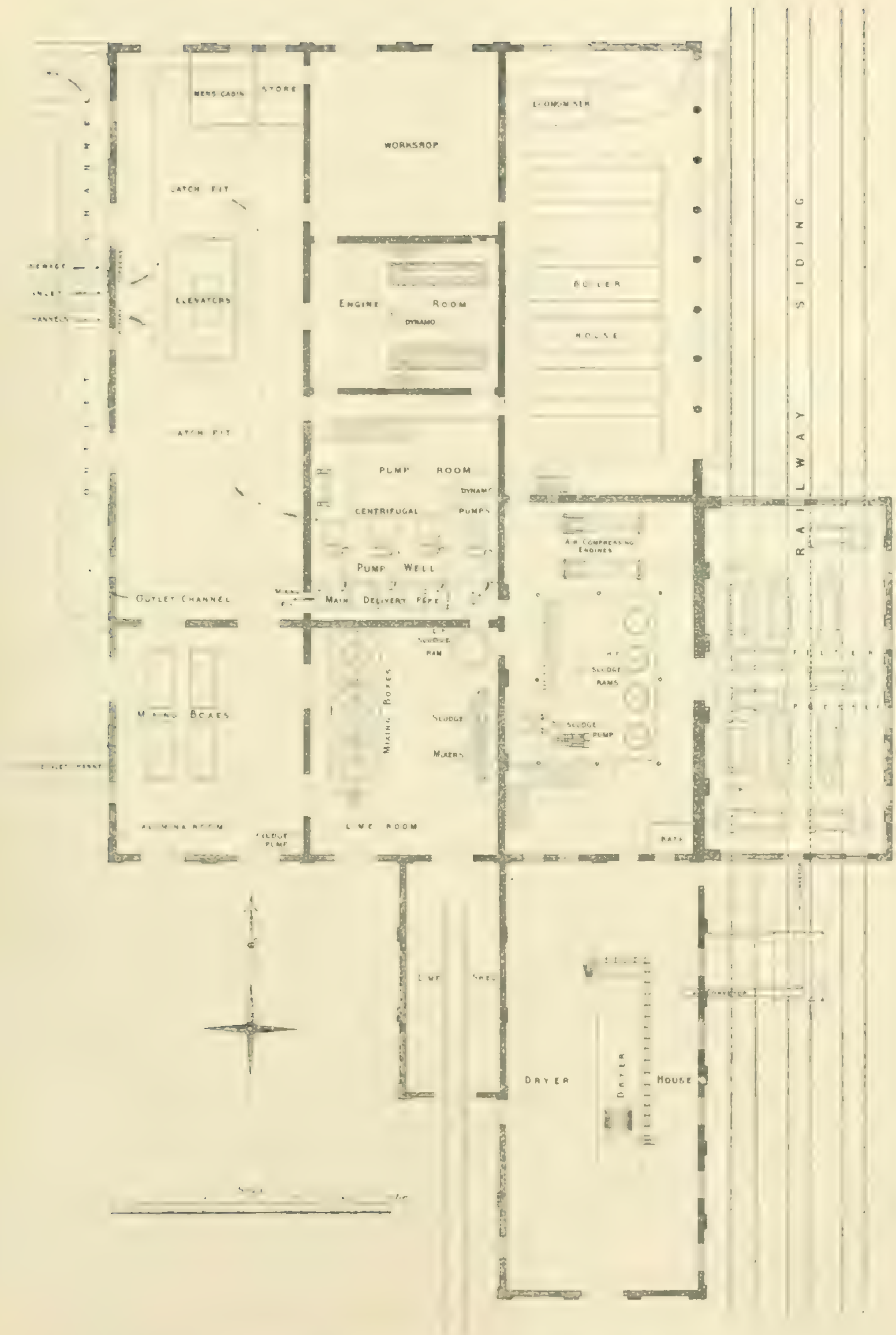
On the south bank of the river Clyde the surface levels of the drainage area are less favourable for the conveyance of sewage and rainfall by gravitation than they are on the north side, according to the distribution of population at present, but the future development of the territory included will reduce the difference in the volumes conveyed by the gravitation and pumped sewers. A storm-water relief sewer is to be constructed in Kingston district to discharge the rainfall carried by the outfall sewer. The sewers on the south side of the river, in the third section, follow for the greater part of their course the line of public streets and roads. A pumping station is located at Kinning Park, where the low level sewage has to be raised 35 ft., and another at Braehead, where the lift is 21 ft. The sewage of Paisley and Renfrew will be brought to the works in low-level sewers, and requires to be pumped.

The works for the treatment of the southern sewage at Braehead will, like those of Dalmuir, have the great advantage of river frontage, with facility of water carriage for receiving and despatching materials.

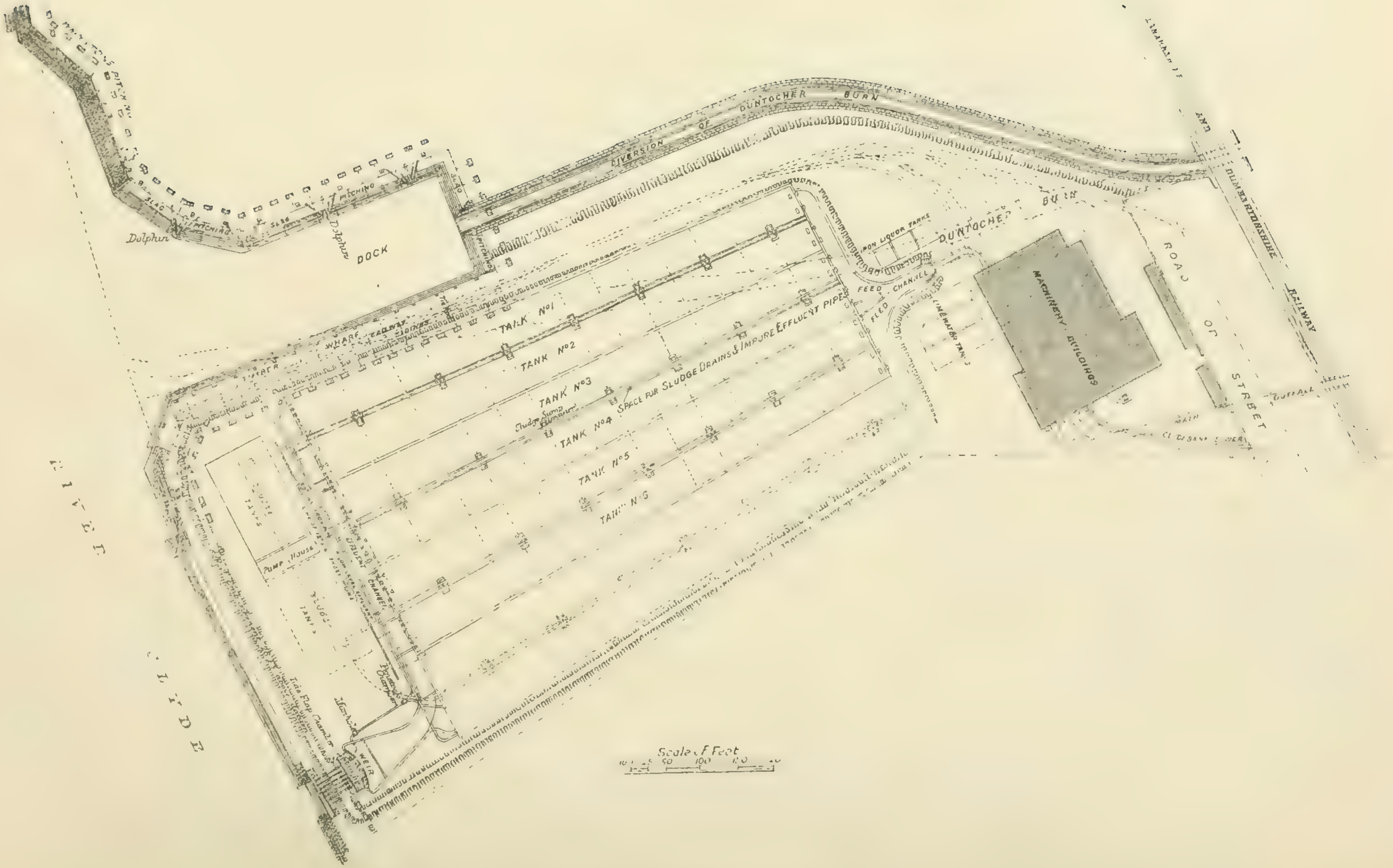
SEWAGE TREATMENT.

The construction of the sewage works at Dalmuir was held over to ascertain the applicability of bacterial methods to the treatment of Glasgow sewage by means of experimental plant constructed at the Dalmarnock Works, after the operations at Manchester had been watched. The whole subject of bacteriology is defined in an engineer's opinion by extravagant statements and obscured by looseness of definition. The phase of the question that concerns the engineer is, Does the principle of bacterial treatment of sewage possess an economic aspect? Will it compete with chemical precipitation in actual practice? Mr. M. A. B. Macdonald, the City Engineer, Glasgow, replies in the negative. Bacteriological treatment is another name for filtration, and sewage cannot be filtered. If the separation of solids be essential before the filter stage is reached, and if the filters themselves have to be allowed indefinite periods of rest, no reliable estimate of the cost of treatment can possibly be arrived at, and the whole matter remains in the theoretical stage, the only thing plain being that the system inevitably requires for its operation more time and more space than are required for chemical precipitation. But the flow of sewage is permanent, and increased space means augmented cost for land and for construction to a degree that far exceeds the charge for chemical treatment.

In each converted tank at Dalmarnock were placed originally double filters or contact beds, the whole filtering surface thus provided being 7,176 square feet. The construction of these bacteria beds and the whole



PLAN OF MACHINERY BUILDING AT DALMARNOCK SEWAGE WORKS.



PLAN SHOWING TANKS, OUTLET WORKS AND DOCK AT DALMUIR STATION.

arrangements of the experimental plant were carried out with the co-operation of the Corporation chemist, The open septic tank has a capacity of 200,000 gallons, of which quantity the bacteria beds are able to dispose of 32,617 gallons at each filling. It was expected that when the bacteria beds were thoroughly matured, they might be filled and discharged four times daily, but it is not safe to assume that, working with great volumes of sewage, bacteria beds can be charged oftener than three times daily. The filtrate from the second contact bed is of a quality which exceeds the requirements of any sewage effluent, and equally satisfactory results should be obtained if the same method of treatment is adopted at Dalmuir.

CHEMICAL PRECIPITATION OF SEWAGE AT DALMARNOCK.

The system of sewage treatment which is now adopted at Dalmarnock is, in brief, chemical precipitation by means of under-surface continuous flow. The drainage received at the works is of a complex character, consisting for the most part of industrial refuse charged with suspended matters that vary from 20 grains to 1,000 grains per gallon. The treatment of such sewage is a matter of great difficulty, and the proportion of the chemical ingredients undergoes frequent change during the day.

After much investigation on the part of the Sewage Committee and their expert advisers, it was resolved to adopt at Dalmuir and Braehead the same method of sewage treatment as that which has for the last seven or eight years been in successful use at Dalmarnock ; with this exception, that the sludge presses which, by the situation of Dalmarnock Works, have been employed there, are to be dispensed with, and the liquid sludge carried out to sea.

WORKING RESULTS.

The working result of the sewage treatment in daily practice at Dalmarnock obliterates every trace of suspended matter, and effects 30 per cent. of chemical purification, calculated on the basis of oxygen absorbed in four hours at 27 deg. C. The result leaves something to be desired, but economy imposes a limit on achievement in this direction.

The following abstract from a report by the General Manager of the Dalmarnock Sewage Works gives the results of the operations during the year 1900-1901, in comparison with those during the preceding year :—

	1899-1900.			1900-1901.		
	Gals.			Gals.		
Total sewage dealt with	4,514,300,000			5,391,536,000		
Average daily quantity	12,367,945			14,771,332		
	£	s.	d.	£	s.	d.
Average cost of chemicals	0	10	1[illegible]	0	6	11[illegible]
	Tons.			Tons.		
Crude sludge extracted by precipitation ...	170,112			216,248		
	Tons.	cwts.		Tons.	cwts.	
Sludge cake from filter presses	23,227	10		27,828	17	
Sludge raised by elevators	1,001	15		1,342	15	
Total solids	24,310	5		29,171	12	

	Per ton.	Per ton.
Cost of pressed sludge cake ..	2s. 4d.	2s. 4[illegible]d.
Cost of sending sludge cake to tips, including hire of sewage department wagons	6[illegible]d.	[illegible]

Working expenses per million gallons of sewage treated :—

	1899-1900.			1900-1901.		
	£	s.	d.	£	s.	d.
Pumping .	0	10	4[illegible]	0	14	2
Precipitation, including chemicals ...	0	15	7[illegible]	0	14	[illegible]
Filtration, including coke	0	7	5	0	4	3
Sludge pressing	0	12	0	0	12	3
Sludge to tips	0	1	3[illegible]	0	1	6[illegible]
	2	6	9[illegible]	2	7	3

From the above statement it will be seen that during 1901, 5,391,536,000 gallons of sewage were treated at the works, which are equal to a weight of 24,470,501 tons 6 cwt. 0 qr. 21 lb., being an average of 14,771,332 gallons, or 67,042 tons 10 cwt. 0 qr. 9 lb. per twenty-four hours.

From that liquid sewage there were extracted by precipitation, 216,248 tons of crude sludge, which were reduced by filter pressing to 27,828$\frac{17}{20}$ tons, at an average cost of 2s. 4$\frac{7}{10}$d. per ton of pressed cake. In addition to that quantity, 1,342$\frac{15}{20}$ tons were raised direct from the catchpits by the elevators. These two quantities make a total of 29,171$\frac{12}{20}$ tons of solid matter removed from the sewage during the year, which were disposed of thus :—

	1899-1900.		1900-1901.	
	Tons.	cwts.	Tons.	cwts.
Deposited on ground at works	6,898	0	5,010	10
Sold as manure by sewage department ..	8,300	10	8,365	0
Manufactured in globe fertilizer	1,552	16	816	11
Despatched by rail to refuse tips	7,567	10	14,397	2
	24,310	15	29,171	12

Dispcsed of from stock :—

	1899-1900.		1900-1901.	
	Tons.	cwts.	Tons.	cwts.
Sold as manure by sewage department ...	3,817	6	1,601	7
Despatched by rail to refuse tips	16	3		
	3,833	9	1,601	7

During the year 507$\frac{9}{20}$ tons of "Globe" fertiliser were sold at prices ranging from 8s. to 14s. per ton, free on rail, and 10,056$\frac{7}{20}$ tons of pressed cake were sold at about 1s. per ton, free on rail. The quantity

of sewage [illegible] disposed of at the Dalmarnock Works [illegible] gallons [illegible] discharged into a comparatively pure tidal stream of fifty fold [illegible]

It has not yet been scientifically ascertained what degree of saturation is needed to secure innocuous conditions in the admission of sewage-effluent into flowing water, but there is in this case as near an approach to the complete elimination of every element of objection as seems necessary. Further down the river, at Braehead and at Dalmuir, the 97,000,000 gallons of purified sewage will come in contact with 3,000,000,000 gallons of tidal water, and may with safety be left to natural agencies for their further improvement, more especially as the quality of sewage to be dealt with hereafter on these lower reaches of the river will be of a simpler character than that which is being treated at Dalmarnock, and, therefore, likely to yield an effluent of a better character. There is the greater reason to expect this, as the form and dimensions of the precipitating plant at Dalmuir and Braehead will be more effective than the original installation at Dalmarnock.

The works at Dalmarnock were designed by the late Mr. G. V. Alsing, and were regarded at the time of their construction as highly creditable to their designer, embodying, as they then did, the latest results of experience and scientific research. They were arranged as has been shown, for intermittent precipitation, and worked in connection with coke filters, through which the sewage effluent was passed on its way to the river. Recently it has been found desirable to extend and convert the Dalmarnock works; the precipitation tanks are now worked in continuous flow, and the use of the filters has been abandoned, as it was found that the process deteriorated the effluent instead of improving it.

THE DALMUIR PRECIPITATION TANKS.

The precipitation tanks in course of construction at Dalmuir, which are to be worked on the system of under surface continuous flow, are more favourably situated than those at Dalmarnock, each being about 750 ft. in length, allowing opportunity for more complete precipitation than is afforded in the shorter tanks at the Dalmarnock Works, and effecting a saving in the reduced proportion of chemical agents required for the process.

The works authorised under the statutes of 1896 and 1898 include thirty miles of outfall and intercepting sewers, as well as four separate pumping stations, and two sewage works for the treatment of the collected drainage, the one at Dalmuir, the other at Braehead.

The extent of the lands belonging to the Corporation at Dalmuir and between the line of the Lanarkshire and Dumbartonshire Railway and the river, available for sewage works is one hundred acres, and eighty acres of additional land are required to provide room for the tanks and bacteria beds, railway sidings, roads and other means of communication. There are no reliable data to furnish information as to the cost of working the bacterial system on a great scale, but there is no doubt that considerable annual outlay will be needed for attending to the bacteria beds, raking over the filtering material, regulating the periods of rest, and kindred work. Due provision has to be made for collecting and disposing of sewage sludge, as large quantities of that material will always require to be dealt with.

PROGRESS AND COST OF THE SCHEME.

All the sections of the western undertaking might have been completed before this had not the Town Council, at the outbreak of the South African War, directed that capital expenditure on works should be suspended owing to the advanced rate of interest on money. It is expected, however, that during the course of this year (1903) the work on the northern bank of the river will be so far advanced as to permit the greater part of the sewage derived from the western area being purified, and a corresponding improvement in the condition of the river brought about.

The works on the southern bank, the details of which have already been elaborated, will be pushed forward, but a longer time must necessarily elapse before their completion can be effected, probably 1907.

The original estimates of the cost of this great scheme have been largely exceeded, for various reasons which need not be gone into here. The present estimated cost of the whole scheme is £2,100,000, but the ultimate cost will probably be considerably more. Then the Clyde will be comparatively clean and sightly once more, and the descendants of the lordly salmon captured by the rod of Saint Mungo may return to the haunts of their ancestors.

Engineering Apprentices and Scientific Training.

A NORTH OF ENGLAND SCHEME

L[illegible] the non-appreciation of technical training by manu-[illegible] we are pleased to have our opinion on this matter [illegible] their apprentices. The latest scheme of this descrip-[illegible] Director of Messrs. Richardsons, Westgarth and Co.) for adoption in the Hartlepool engine works. The scheme which was adopted on the 1st of October for a trial period of three years, bears on the face of it the potentialities of success. It not only points out the way by which apprentices can make themselves efficient workmen, but also offers an increment of weekly wages to all students who set themselves to attain a [illegible] significant is the concluding paragraph, from which it may be noted that the scheme assures direct promotion to energetic and successful students, and also opens up access to the drawing office.

DETAILS OF THE SCHEME.

[illegible] will be awarded marks as follow :—

For each approved examination in Science or in practical mathematics, passed during the year ..	20 marks
[illegible]	[illegible]
For good conduct, perseverance and [illegible] maximum of	40 marks

An examination in practical mathematics will be held at these works in May of each year for apprentices who have attended not less than twenty-five lessons in this subject at the evening classes during the session, but who have not passed the science examination in mathematics, Stage I.

Marks for time-keeping will be deducted at the rate of one mark for every three hours lost, but no deduction will be made for special leave, or for sickness, if certified by a doctor.

Conduct marks will be awarded by the chief foremen [illegible]

Very good	40 marks
[illegible]	[illegible]
Fair	[illegible]
Moderate	10 marks
Bad	[illegible]

An apprentice obtaining 60 marks will have the sum of sixpence added to his weekly rate of pay for the [illegible] be proportionately increased.

For example, an apprentice wh[illegible] in the workshops during the past year, a maximum of 40 marks ; total, 120 marks. This will entitle him to an increase of one shilling per week on his rate of pay from October 1st, 1903, for one year, but payments under this scheme cease on the termination of apprenticeship or on dismissal.

Should an apprentice obtain, say, 30 marks for time-keeping, and 40 for good conduct, perseverance and progress, or a total of 70 marks, his rate of pay would be increased sevenpence per week, and so on.

No payment under this scheme will be made to apprentices obtaining less than 60 marks, and appr[illegible] tices who fail to obtain any marks for time-keep[illegible] good conduct, perseverance and progress will be subject [illegible] to half rates for their first year.

[illegible] in the workshops, and admission to the [illegible]

ITS EFFECTS.

We are gratified to hear from Mr. Morison that the scheme has already given marked evidence of success. He writes as follows : "We have been agreeably surprised at the interest and enthusiasm which has resulted in our works since the scheme has been in operation, as the apprentices have kept much better time, are far less trouble to their foremen than formerly, in fact, it is perfectly evident that not only will the standard of apprentices be appreciably raised, but the extra payment made (which, in our case, amounts to £150 for the first year) will be a highly profitable investment."

Mr. Morison's scheme embraces the principle of "payment by results," and is, consequently, calculated to stimulate individual effort. It affords the means by which native ability may be brought to the fore, and makes it very difficult for idleness or incompetency to go undiscovered. It will also serve to bring the foremen into closer touch with the apprentices.

THE EFFECT OF DUST IN MINES.

BY

WILLIAM CULLEN.

The conditons which give rise to miners phthisis are just now the subject of earnest discussion and inquiry in South Africa. In a recent report accompanying Lord Milner's return of mortality amongst the natives employed on the Rand mines, Dr. C. L. Sansom remarked that pulmonary diseases were partly due to the carelessness and ignorance of the natives who did not take ordinary precaution against getting sudden chills when heated by exertion and partly to working in a dust-laden atmosphere. The effect of dust in underground workings has been investigated by a Government Commission.—Ed.

I SHALL not attempt in the following pages to define "miners' phthisis." Statistics show quite clearly that the mortality among miners on the South African fields, as well as on similar fields where the conditions are analogous, are high, and it is a most laudable thing to endeavour to get at the cause and, if possible, to discover a preventive. There is a tendency, however, in the discussions which have lately taken place on this subject, to rush off at a tangent, and to give side-issues a prominence which they do not deserve. On the other hand, it goes without saying that the collective opinion of those entitled to speak with authority, is in favour of the theory of the accumulation and subsequent caking of dust on the tissues, and this is likely to turn out correct, more especially as a similar trouble is well known in various trades.

CAUSES OF DUST.

Let us first realise the conditions of working in a mine. I may be wrong, but I presume that the only two conditions under which a miner can get an overdose of dust are (1) working dry holes with the rock-drill; (2) entering a working before the dust produced by the blast has had time to settle. This of course, under normal conditions, does not take a long time; assuming that it is the primary cause of miners' phthisis, the removal of these conditions, and the substitution for them of a more healthy set of conditions belongs to the realm of mechanical engineering, and already there are indications that the problem is about to be solved. This has been recognised as a problem for many years, and long before the appointment of the Commission at present taking evidence on the subject, attempts had been made to reduce the inhalation of dust by means of masks, atomizers, and sprays. We all know, however, how perverse human nature is—how familiarity breeds contempt—and unless a miner can be provided with a device which does not put him to any inconvenience in any shape or form, he will never go out of his way to use it, unless the non-compliance with regulations regarding its use be made a criminal offence.

I am not going to discuss the relative merits of the three systems which I have just enumerated, but would merely point out that it is just a problem whether it is not better from a health point of view to inhale the dust and work under comparatively dry conditions than to trap the dust and work in sopping-wet clothes with all the other attendant risks. At any rate, this is a subject worth discussing. Now, I do not know whether any of my readers have ever worn a mask for any length of time or not, but even with the best of them the feeling of stuffiness and general discomfort becomes after a time almost unbearable.

MASKS.

In certain industries legislation has made it compulsory for the workpeople to wear masks, but for the reason just referred to, and incidentally to the want of common-sense in the design, the workmen often seek by every means to avoid having to wear them. Masks will, therefore, I am afraid, never be popular, but as a preventive against the inhalation of dust they are no doubt very efficacious.

It has been contended, with plenty of reason, that the atmosphere in which the miner works has a great deal to do with his health; also that in some places, such as blind drives, rises, and winzes, the ventilation is none of the best, so that it would be unhealthy for any person to work in them. I merely mention and emphasise this fact to point out that it can have no possible connection with miners' phthisis as a specific trouble. Of course, continuous working in a bad atmosphere will make any person physically unfit, and therefore predispose him to all sorts of trouble. I have no doubt whatever that this condition of

things will be remedied [illegible] the mining companies to do more than they are doing now, but the obvious solution of the question is to improve the ventilation and carry air-pipes wherever possible. This is already being recognised, and in the long run it will repay the attention bestowed upon it.

There is still the possibility that even with improved ventilation the gases exuded by the rock itself or from fissures may be sufficient to make the atmosphere bad, but this also can be avoided. There is no reason why a miner should not wear a mask, the interior of which is continually supplied with a current of cool air direct from the air-pipe working the drill. This has been proposed by Dr. Amyard, and, although it can only have a very limited application, one can imagine circumstances under which it would be extremely beneficial. Of course, such an arrangement must minimise the stuffy feeling already referred to, and if a light rubber tube were made the connecting medium, one can conceive that the inconvenience involved in its use would be very little indeed. The object of such an arrangement would be twofold—first, to catch the dust; secondly, to supply the miner with fresh, cool air. The inconveniences of the arrangement are very obvious, the principal one being that it could only be really efficacious when a man, say a machine-man, was working at his specified place. It would be of no use if he had to move about.

COMPRESSOR EXHAUST FOR VENTILATION.

Another question is raised here, viz.—Is the air supply from the compressors really purer than the air of the mine after all? This looks almost like begging the question, seeing the compressors are primarily erected for helping and improving the ventilation; but it is undoubted that even under the best conditions considerable quantities of oil are carried to inconceivable distances. From personal experience I know that it is a very difficult thing to prevent this, and no system of trapping can obviate it altogether, but it can be reduced to a minimum.

One obvious precaution is to employ only good cylinder oil having a very high flash-point. When there are even large quantities of oil in the compressed air it has yet to be proved that it does any permanent harm, but if the oil has ignited one can imagine that some of the gases produced would be the reverse of helpful. These things can, on the face of them, have no possible connection with miners' phthisis. All we can say about them is that they are problems awaiting solution, and they are problems for discussion.

DUST UNDER THE MICROSCOPE.

One other point, and one which has a more direct bearing on the subject proper, is the dust itself. Has the reader ever examined the dust under the microscope? If so, he will readily understand how dust can be so dangerous. It is merely a mass of knife-edges, rough saws, and every other shape except that of round pebbles—a ghastly looking conglomeration. It is also possible for these particles to carry germs, although it does take a lot of imagination to see how harmful germs could exist in banket at 400 ft. or 500 ft. However, once the dust-particles are in suspension in the air, they would form a splendid anchorage for any germs which had strayed away from their proper moorings. One finds it difficult to realise that disease would result from the inhalation of banket dust; but, of course, there are the possibilities.

WET AN EVIL.

I have already referred to the unhealthy conditions under which the miner works, and these are generally recognised. In wet workings a man cannot help getting wet, and if he does not change immediately he comes to the surface and exercise due precaution, he is bound, sooner or later, to contract some pulmonary trouble. There are, of course, men who can stand any amount of this sort of thing, and among the colliers in that part of the country which I hail from, the mortality is not particularly high, although most of the mines are wet. This merely shows, however, that the dust which the miner inhales here is more harmful than coal-dust, but this is generally recognised. Legislation and proper supervision can easily remedy this part of the problem, but it can never prevent a man having to work all day in sopping clothes and with wet feet. This again can have nothing to do with miners' phthisis as a specific trouble.

GASES FROM EXPLOSIVES.

The great rival to the dust theory is that of the noxious gases, and we hear people say repeatedly, "Well, they may talk as they like about dust, but I believe that the explosive we use has more to do with the thing than everything else put together." Others, again, not quite so positive, affirm that the gases have quite as much to do with the trouble as the dust, and there are many shades of opinion between these two extremes. Fortunately it is not necessary for me to say much about the nature of the gases produced by the explosives in use; and the matter is not complicated by the use of more than one class of explosive. Blasting-gelatine is an easy first, and when treated properly, and when of good quality, produces no noxious gases whatever. This is a statement which is absolutely incontrovertible. But we must admit that in practice the ideal state of things does not always obtain, and that gases are very frequently produced which are harmful. The formation of these gases accounts for a man getting "gassed," but there is really no occasion for this taking place—*i.e.*, in ordinary cases. Let us see for a moment what could possibly happen in the worst possible circumstances. The only really harmful gases which could be produced are carbon-monoxide, carbon-dioxide, and nitrogen-oxides—*i.e.*, of course, from the explosive.

But, in addition to this, there are the gases formed from the combustion of the fuse, and it must be at once admitted that they manifest their presence through

a most pronounced smell and smoke. Carbon-monoxide and dioxide, as well as sulphurous acid and sulphuretted hydrogen (the latter in small quantity), are all produced, as chemical analyses show, but although the latter two have very characteristic odours they are seldom, if ever, recognised by their smell. Sulphuretted hydrogen is a most deadly gas to inhale, and I should say that it is the only one out of the four mentioned which could cause any inconvenience. But has any one of them any connection with miners' phthisis? I do not believe it for a single moment; but to say that the constant breathing of the fumes from the burning of fuse is good for a miner, or for miners' phthisis, I also do not believe. The amount of smoke produced is very alarming in appearance, and an atmosphere charged with it is very unpleasant to breathe, causing a catching sensation in the back of the throat and in the chest, but this rapidly passes off. We see, therefore, that the worst which can be said about the fuse-gases is that they are unpleasant and possibly unhealthy, but we find it difficult to accuse them of being anything worse. There are other and minor possibilities which may be dismissed in a word: First, the presence of vapour of mercury (from the detonator) in the atmosphere. At the most this can only amount to 1 gramme fulminate for each charge, so it may be dismissed as out of court. Secondly, the occasional presence of nitro-glycerine as vapour in the atmosphere. It is possible for this to happen, but although most violent headaches and general inconvenience are caused by the breathing of nitro-glycerine vapours, the accepted theory is that they are rather beneficial than otherwise; and, judging by the health statistics of those who have to inhale them daily, one can safely say that by themselves they are absolutely innocuous. We are therefore driven back to the last line of defence, or, rather, of attack, in this case—viz., the noxious gases produced from the explosives themselves—and it may be advisable to consider them by the processes of analogy and elimination.

THE THREE DANGEROUS GASES.

The only gases which we need consider, therefore, are carbon-dioxide (*i.e.*, carbonic acid), carbon-monoxide and the oxides of nitrogen. Now, none of them are good, and the mixture is decidedly bad, as is evidenced by the fact of men and boys getting "gassed," and that sometimes very badly. In the coal mines at home, and, indeed, all the world over, black powder was used exclusively until very recently. It produces on explosion, large amounts of carbon-monoxide and dioxide, as well as sulphurous acid, yet we never heard of miners' phthisis among coal miners. They suffer, as all of us do, from the effects of damp, and they occasionally get an overdose of gas; but nowadays, since the regulations for blasting have become more stringent and are being more strictly enforced, we seldom hear even of this. Carbon-monoxide and carbon-dioxide can have no possible connection with miners' phthisis as a specific disease. Carbon-dioxide will suffocate the strongest man, and carbon-monoxide will cause death through combination with the hæmoglobin of the blood, thus excluding the free absorption of oxygen; but the action of these two gases on human lungs has been so thoroughly investigated that we cannot help coming to any other conclusion than that just given.

I now come to the last gas of all, which, for simplicity's sake, I shall call nitrogen-peroxide. There is no doubt but that this gas has most harmful effects on the human system, and I speak from experience not in mining but in chemical industry, where we come across it very frequently. I have known a great many cases where men have inhaled what seemed to be small quantities of this gas, but in less than two days they were dead. In one or two cases they died within twenty-four hours, and the symptoms in nearly every case were the same. At first the man felt pretty well, and was able to take food; but the collapse came with fearful suddenness, the symptoms at the end being invariably what doctors call "bronchial pneumonia." What makes these cases so difficult to deal with is the fact that the man always feels quite well for some time, and generally asserts that there is nothing wrong with him. Quite recently I had four such cases to deal with in one day, and I ascribe their being alive and well now to the fact that from the first I insisted upon treating them as patients. It is not the object of this paper to go into the scientific reasons for this action of nitrogen-peroxide, and I content myself with stating these facts. This much I must, however, say in addition: If a man is at all weakly, and if he has any symptoms of pneumonia on him, he will be attacked very readily by nitric-peroxide; if he is badly "gassed" he will be likely to die. You will see, therefore, that this is bringing us a little nearer to the specific disease, and, as I have no intention of falling out with medical opinion, I prefer to leave the matter at this stage.

SHOT-FIRING.

I would emphasise a fact that when nitric-peroxide is produced it is the result of an abnormal shot, a bad explosive, or other similar cause. The next question is—Can this be prevented to any extent by legislation? Most undoubtedly it can. I do not know whether any of my readers ever had much to do with shot-firing, but if they have, they will no doubt consider themselves experts in the matter. Now, this is the position of most miners, and I am glad to say that it is generally justified by results; but it is also a fact that many so-called experts are in fact the very reverse, and by their treatment of the explosives they not only court disaster for themselves but run the risk of injuring others. Legislation could do much to insist on one definite method of charging a hole; and if good detonators and, above all, good fuse were employed we should hear very much less about "gassing" with all its baneful results. Of course, no amount of legislation will make a bad explosive good, but this point I shall say nothing about meantime.

The Effect of Dust in Mines.

ELECTRIC FIRING.

When on the subject of fuse I referred to the gases and smoke produced, and if they are proved to be harmful the obvious course to follow is to blast by electricity. I know this procedure is more expensive, and it demands more care on the part of the shot-firer, but in the coal-mines at home no other kind of blasting is permitted. I am not sufficiently practical to say how it would work out here, but it is a subject worth very serious consideration; and, only shot-firing by electricity should be allowed in shaft-sinking. Another very great advantage which this system would have is that it would not matter in the least whether the detonator was inserted up to the neck or only half home as we do with ordinary detonators. With a great deal of the fuse now in use spitting is very common, and fumes are very often caused through this.

NEUTRALISING AGENTS.

Let us now suppose that electric blasting were in general use, and that we had only to deal with dust in suspension while drilling dry holes, and dust in suspension and the gas from the explosion after a blast. I think no one will disagree with me when I say that the sooner the miner can get back to the face with comfort the more work will be done for the same money. I shall go further, and say that sprays, atomisers, or whatever else they are called, all assist in laying the dust and damping the gases. It takes no great stretch of the imagination to think of some mechanical device connected with the air-supply which the shot-firer turns on as he gets away from the face, and which can work away for as long as he likes after the blast has taken place. This spray will settle the dust as already said, but in the case of a bad shot it can do little else; and if the ventilation is not very good, noxious gases will hang about for a long time and prevent the men returning to the face. Now, I understand that dilute caustic alkalies have been employed instead of water, and the idea is an excellent one, as it will assist to absorb the large amount of carbonic acid formed. On carbon-monoxide it has no action whatever, not even a solvent one, and no cheap solvent will ever be found to dissolve it. However, it certainly is not so harmful as the nitric-peroxide by a long way, and I have proposed to use ammonia in addition to the alkali in order to neutralise any formed, and it does so very efficiently. A very dilute solution of ammonia serves the purpose very well, and although a 1 per cent. solution has no smell, yet if sprayed through an atomiser it soon fills the atmosphere with ammonia-gas, which, besides doing as I have said, makes one feel quite refreshed.

The foregoing notes were written some considerable time ago, and as they were being written I was making experiments on various matters referred to in the notes, and since then they have been continued. The results of these experiments have modified the views I have expressed, but only to a slight extent.

A SOLUTION.

I regret exceedingly that it is impossible for me to say anything about the experiments I have been making in connection with these matters, except those that have been carried out by me in a private capacity. I consider, however, that the question of inhalation of dust produced by the rock-drills when operating in dry holes is as good as settled, and when the device which has been invented for the purpose becomes more freely known it will reflect the greatest credit on the energies of a mine manager who is already very much respected. With regard to the fumes and the dust produced on explosion, the matter is a very much more difficult one; but, all the same, the results obtained so far seem to point to ultimate success. I should also add that it is now possible to obtain electric time-detonators. The great objection to electric shot-firing in these fields in the past has been that all the shots went off simultaneously. Now it is possible to set them off at intervals of several seconds, which is a very decided advance on anything accomplished in the past.

Read before the Chemical, Metallurgical, and Mining Society of South Africa

THE UGANDA RAILWAY.

PROGRESS OF THE WORKS AND REVENUE.

IN the early part of the present year we were enabled to present a brief survey of the Uganda Railway, which has had such a wonderful effect in developing the resources of British East Africa. An instructive sequel is to be found in the report which has been issued by the Mombasa-Victoria (Uganda) Railway Committee on the progress of the Works and Revenue Working, 1902–1903.

The report, which covers the year ended 31st March, 1903, states that by an agreement come to with the German Government, the survey of the southern portion of Lake Victoria has been commenced. The importance of these surveys to the railway is that its two steamers, the *Winifred* and *Sybil*, of 600 tons each, will be able to make the round voyage in safety, and to earn freight for the railway from all the lake ports.

The two-mile-zone along the line is now being adminstered by the Protectorate Government on behalf of the railway. The boundaries of land specially reserved for future railway extensions round the various stations have been marked out, and the plans registered.

With the exception of a small tunnel at mile 526 and two other short deviations, the earthworks are finished. The total quantities during the period of construction were :—

Rock ..	.. 914,605	cubic yards
Earth ..	.. 9,180,505	,, ,,

of which 126,575 cubic yards of rock and 945,446 cubic yards of earth were excavated during the year under review. Nine large viaducts on the ascent of the great Mau Range and eighteen on the descent were erected during the year, and the whole of the bridges and culverts have now been completed up to Muhoroni, mile 548.

The total quantity of bridging on the line includes the Salisbury Bridge across the Macupa Strait which divides the Island of Mombasa from the mainland (twenty-one spans of 60 ft. plate girders on screw piles); thirty-five steel trestle viaducts on the Kikuyu and Mau escarpments; 104 girder openings ranging from 12 ft. to 100 ft. in span; 1,280 minor bridges and culverts.

The permanent three-wire telegraph, which was erected throughout the line by the railway staff, and which still remains charged against railway construction, has been taken over by the Protectorate for public service, two wires being rented by the railway for train working at £1,557 per annum. The rails are now laid on the permanent alignment throughout with the exceptions noted under "earthworks." The total amount of platelaying includes 624 miles of main line and sidings, and the laying and removal of about a hundred miles of deviations. The more important portions, with the exception of the last thirty miles (which is on black cotton soil), have been ballasted. Every effort is now being made to make these thirty miles secure; when this has been done the remainder will be accomplished gradually.

The station buildings have been completed throughout the line. There are forty-three stations, including Mombasa, the terminus at the coast; Port Florence, the terminus on the lake; Nairobi, the headquarters, and four other engine-changing stations. The permanent workshops at Nairobi and the small workshop at Port Florence are completed, and fully equipped for any repairs to steamers and locomotives, and for repairs and renewals of any description of rolling-stock.

One of the two steamers sent out has been erected at Port Florence, and is now plying between lake ports. The second one will shortly be completed. At Kilindini (Mombasa) the temporary pier erected for landing materials for the construction of the railway has been made permanent by substituting coral rock and iron piles for the woodwork. Alternative surveys are complete for works which will enable this pier to be the terminus of the main line whenever it is decided to make Kilindini the landing-place for goods. At Port Florence, the lake terminus of the railway, a pier, sufficient to accommodate the lake steamers, is being erected.

The numbers of labourers of all kinds employed year by year on the railway since its commencement have been :—

		Imported from India.	Locally employed.	Total.
1896–1897	..	3,948	1,349	5,297
1897–1898	..	6,086	1,372	7,458
1898–1899	..	13,003	2,509	15,512
1899–1900	..	16,030	2,690	18,720
1900–1901	..	19,742	2,506	22,248
1901–1902	..	13,646	2,335	15,981
1902–1903	..	6,704	1,865	8,569

Excluding the receipts for the carriage of construction material, booked at actual cost incurred, the receipts from public traffic during the fifteen months under review were £115,313. The falling-off in receipts is due to a reduction in rates which has already secured a larger tonnage of goods lifted, especially under the heads of salt, kerosene oil, beads, and brass and other wire. But the policy of this reduction will in all probability be still further justified by increased receipts, the business done, as measured by traffic ton-mileage per mile open, having increased by 44 per cent. as compared with 1901.

During the fifteen months, January, 1902, to March, 1903, the total expenditure on working both construction and public traffic trains was £325,574, the receipts from public traffic were £115,313, and the capital account has been debited with £148,148, the actual expenditure incurred, as nearly as it can be calculated, in running construction trains and carrying construction material in ordinary trains. The net result during the official year, the 1st April, 1902, to the 31st March, 1903, was a deficit of £49,690.

The actual work done, and the gross receipts from public traffic during the calendar years 1900 and 1901, and the period of fifteen months from the 1st January, 1902, to the 31st March, 1903, are shown below :—

	Jan. 1st to Dec. 31st, 1900.	Jan. 1st to Dec. 31st, 1901.	Jan. 1st 1902, to Mar. 31st, 1903.
Mean mileage worked	340·70	507·57	584
Total train-mileage (including construction trains) ..	1,181,280	1,483,874	1,430,122
Average number of trains over the whole line daily ..	4·13	4·01	1·8
Traffic train-mileage	883,832	1,109,174	956,916
Traffic, goods, ton-mileage	2,067,482	2,283,872	4,702,271
Gross earnings from public traffic ..	£65,805	£80,797	£115,313
Gross earnings from public traffic per mile per week ..	3·235	3·061	3·037

THE PRESERVATION OF WOOD FROM FIRE AND DECAY.

BY

SIR RALPH MOOR, K.C.M.G.

The need for a satisfactory method of preserving wood from fire was brought into additional prominence recently by the lamentable Paris tube catastrophe. Sir Ralph Moor, K.C.M.G., who has made a careful study of the question, here presents an account of the Ferrell processes which have already gained marked distinction, and have been found to preserve wood effectively, not only from fire, but also against the ravages of time.—Ed.

IN a recent issue of the *Times** I was enabled to call attention to the valuable discoveries and inventions of Mr. Joseph L. Ferrell, of Philadelphia, for treating wood to preserve it from fire and decay, for which the inventor has recently been awarded the Elliott Cresson gold medal of the Franklin Institute of Philadelphia, which is an institution somewhat similar to the Royal Society in England. The award in question is the highest one in the gift of the Institute. The importance of the position held by wood for all structural works cannot be exaggerated, and it is particularly unnecessary, in a magazine devoted to engineering, shipbuilding, and other branches of a similar nature, to call attention to it. It may, however, be of some interest to give a slight sketch of the history of the work hitherto undertaken to preserve wood from the destructive elements of fire and decay. The subject is one that has occupied attention from the earliest days, if we may give credence to the statement by Aulus Gellius that during the siege of Athens by Sylla, Archelaus constructed a wooden tower which could not be set on fire, the wood having been impregnated with alum. Since those early times sporadic effort has been made to discover some process that would protect timber more particularly from fire, and the question of protecting it from decay has also received attention. Up to the beginning of the present decade, however, the sum of values arrived at as the result of all recorded study in this direction may be stated as :—

(1) Wood is susceptible of absorbing varied percentages of liquids.

(2) That certain chemical solutions when injected into the cellular structure of the wood and afterwards dried, leave a residual deposit of dry chemical therein which, with water, formed the original solution.

(3) That such impregnation may be effected by mechanical pressure and other processes.

(4) That such deposit of chemical substance in the wood cells has in some cases a preservative and in others a fire resistant effect.

* Issue of September 2nd last.

Practically the foregoing condenses the whole state of the art up to a very recent period. The mechanical saturation of wood is really a new art, developed less than thirty years ago, and carried out in an apparatus designed to saturate timber with preservative solutions.

At the present day, as far as can be ascertained, there are in existence five plants for preserving wood in England, three in France, five in Germany, and fourteen in the United States, all using the original apparatus and system of saturation. The prevailing belief appears to be that the interfibrous and cellular system of wood contains elements denominated sap, which are regarded as vicious and generative of destructive fungus. This belief appears to have originated from the difficulty experienced in saturating in preservative solution woods of an excessively sappy nature, which were found, owing to the presence of the elements denominated sap, to resist saturation. It was consequently deemed necessary to remove these elements, and an effort was made to get over the difficulty by liquifying the sap in a steaming process, and then exhausting it by the vacuum pump, which process, according to a scientific journal, "leaves the wood in the condition of a finely divided honeycomb." The steps of this original process for saturation are, after introducing the timber into the cylinder :—

(1) To introduce steam to liquify the sap.

(2) After prolonged steaming to remove by vacuum pumps the elements so liquified, which operation requires many hours.

(3) To fill the cylinder with the preservative solution, allowing it to impregnate the wood so far as it will by its own infiltrative action.

(4) Finally, to apply hydraulic pressure to complete the saturation.

Dealing with the first two operations, it has been conclusively proved that the strength of the wood is seriously impaired by the steaming and exhaustion of the liquified sap by vacuum pumps, and it must, I think, be evident that no substance in nature can be brought in contact with a vacuum without damage to its structure ensuing. Referring to the two latter operations, the methods of saturation are in all cases

excessively slow, and in many cases incomplete. The difficulty of obtaining the necessary pressure to effect absolute saturation with the original mechanical apparatus is, owing to defective construction, insurmountable, and exhaustive experiment in this direction has proved that the attempt to effect saturation with it in large timbers results in damage to the fibre through communicated shock from the pressure pump. Owing to the difficulty of forcing the solutions into the timbers, they are in most cases so dilute as to be practically ineffective, and in many cases the substances used are of a volatile nature and evaporate under exposure to atmospheric influences. Finally, the cost of existing methods of treatment is so excessive as to be prohibitive of timber so treated coming into general use.

The first study necessary in this art is evidently a critical examination of the structure of wood generally, and of each kind of wood in particular, in order to determine the possible general methods of treatment, as also the particular method applicable to obtain the desired results in dealing with each and every class of timber. It is clear from a very cursory examination of timber that it is a substance that lends itself easily to the treatment necessary for preserving it. The cellular and minute pore systems of the body which carry the liquid sustenance of the tree throughout the mass during life are, when the axe has been laid to the tree, the life-flow checked and the timber become structural wood, the means by which the preservative matter may be conveyed throughout the body. All structural wood is subject to constant menace from fire and decay, but the cellular and pore spaces are, even in the hardest timbers, so large a portion of the whole mass as to supply ample room for a protective substance to lodge in such quantity as to completely encompass and permeate each particular fibre. Mr. Ferrell, by the use of his mechanical apparatus, has been able to determine by saturation the exact aggregate cellular and pore space in any given mass of timber of any given description. In a cubic foot of seasoned white pine weighing 360 oz., a thorough saturation increased the weight to 1,170 oz., thus showing that there was room in the cellular spaces of the wood for 810 oz. weight of solution. By this means having definite knowledge of the mixture and density of his solutions, he has been able to arrive at the actual quantity of chemical substance deposited in the wood, and by experiment to determine the actual saturation necessary for each kind of timber to deposit sufficient of the chemical substance employed for effectually preserving it against fire or decay. From the above figures the saturation of white pine attainable with the solution is 220 per cent., but an ample saturation with solution of proper strength to effect the desired object is found to be 120 per cent. In other woods the percentage is as follows :—

Yellow pine	100
White oak	30
Red oak	70
Maple	80
Spruce	50
Beech	60
Birch	70
Ash	90
Poplar	120

To arrive at the necessary knowledge of the structure of wood, thousands of sectional specimens, transverse, radial and tangential from every kind of timber had to be taken to study exhaustively the fibre, cells, pores medullary rays and general structure, and exhaustive experiments had to be carried out to determine the actual saturation necessary in the treatment of each particular kind of timber.

The next point of investigation was to determine a chemical substance suitable for use in solution for the treatment of timber against fire and decay, which should meet the following necessary requirements :—

(1) To render wood fire resistant in the highest degree, and to preserve it against decay.

(2) To have no deleterious effect on the wood, but on the contrary, serve rather as a preservative and absolute germicide.

(3) To have no injurious effect on the strength of the wood, but rather to increase it.

(4) To have no hydroscopic qualities.

(5) To produce no efflorescence.

(6) To preserve the natural colour of the wood.

(7) To have no injurious effect on varnish or paint applied to the surface of treated wood,

(8) To be non-volatile under action of heat.

(9) To exert no corrosive or rusting action on metallic substances.

(10) To admit of wood after treatment being easily worked with tools, and not to add materially to its weight.

(11) To be so cheap as to render the treatment with it commercially practicable.

After exhaustive experiment sulphate of aluminium was determined as the principal chemical substance for employment in the Ferrell solutions—not that it met all the essential requirements, but it was found that in conjunction with other chemicals it could be made to meet them fully, and in this way by careful and exhaustive experiment the solutions were determined. This chemical is cheap, preserves wood, does not promote the growth of fungi, is not hydroscopic, does not produce efflorescence, does not corrode or rust metallic substances, and generally meets the requirements before detailed. It has, however, one bad feature, in that the commercial sulphate of aluminium used in the processes contains free sulphuric acid which, acting on the iron in the mechanical application of the solution in conjunction with a tannic acid in the wood, forms tannite of iron, which blackens the wood. This difficulty is overcome by the admixture of other chemicals. In treating wood as against decay, the sulphate of aluminium solution is used, in conjunction with a chloride solution, which cause a double decomposition, with result that insoluble matter is deposited in the wood, which is preservative as against both fire and decay, and ensures absolute permanency in the treatment. There are other solutions composed of certain chlorides. corrected by the admixture of chemical substances to obviate objectionable tendencies, employed as against fire and decay, and also solutions for use as "filler" and "surface coating," the principal ingredients of which latter I cannot at present give here, as the patents are only now completing, but they are exceedingly cheap, as are the sulphate of aluminium and other chemicals, so that the processes, both for treating wood to preserve it by saturation from fire and decay, and for dressing wood in existing structures with "filler" and "surface coating" as against fire, are commercially practicable.

(To be continued.)

The Economic Outlook in South Africa.

THE economic outlook in South Africa has everywhere become so anxious, owing to the dearth of unskilled coloured labour on the Rand, that this has become an extremely burning question. The salient features of the problem are admirably summed up in the descriptive and statistical statement of the gold mining industry of the Witwatersrand, published as an annexure to the thirteenth report of the Transvaal Chamber of Mines for the year 1902. The Committee of Consulting Engineers responsible for the Report were: Messrs. Hennen Jennings (Chairman), G. A. Denny, F. H. Hatch, F. Hellman (represented by Mr. W. G. Holford), G. J. Hoffmann, W. L. Honnold, S. J. Jennings, J. H. Johns, R. N. Kotze, S. C. Thomson, H. R. Skinner, H. H. Webb, G. E. Webber, P. Yeatman and F. J. Carpenter (Secretary).

NATURE AND EXTENT OF THE FIELDS.

The nature and extent of the Witwatersrand field are first roughly sketched, and the yield obtained in the past is carefully analysed.

The greatest depth from which ore is extracted is at the Robinson Deep, where stopes are worked at a vertical depth of 2,400 ft.; the reef at this depth has all the normal characteristics observed in outcrop mines. The ultimate depth to which mining will be conducted on these fields is dependent on the grade of ore met with and the working costs, the latter being influenced by labour and supply conditions, depth of hoisting, and the temperatures and water encountered as depth is attained. At present the outlook for the last two of these factors of working costs is most favourable, and engineers on these fields are now discussing mining as possible at depths of from 6,000 to 12,000 ft.

With regard to the future of the Witwatersrand fields, it may be confidently stated that there are no general unfavourable indications regarding future yield at present in sight; still it must be remembered that, as working costs are reduced and scale of operations extended, a lower yield per ton must naturally be expected; for it is seen that there is an almost indefinite amount of conglomerate ore, and, as working conditions become more favourable, so will the working of more extensive amounts of low grade ore be justified.

In the past the decrease in yield per ton in proportion to the scale of working has been modified by the process of "sorting out" valueless rock and improvement in the percentage of gold extraction by means of the cyanide process; the extraction has increased from 55 per cent. in 1889 to, in some cases, 90 per cent. in 1899. The elastic limits of these factors have, however, been nearly reached.

THE CARDINAL FACTOR.

The principal factors which will determine the problem are those of time and cost. The vital importance to mining of the factor of time is easily demonstrated. The cardinal factor for consideration is to be found in the working costs. As working costs increase, so will the number of tons of ore crushed decrease and the extent of operations be curtailed. As they decrease so will the extent of the operations increase, as well as the money that is put into circulation. The more men employed at the mines and money coming from the mines, the greater and more prosperous will be the population that is directly and indirectly dependent on the mines.

In the statement of expenditure for wages and stores given by the State Mining Engineer's Department for the year 1898 for both gold and coal mines, the main items are labour, explosives, and coal:—

Labour	= 60·07	per cent. of the total cost.
Explosives	= 11·85	,, ,, ,,
Coal	= 8·20	,, ,, ,,

This statement is somewhat indeterminative as regards the producing mines, but a summary has been prepared which, under eleven divisions, gives the expenditure for fifty-eight producing mines for the year 1898, also seventeen non-producing companies. This shows that 53·44 per cent. of the total cost for producing companies is for labour:—

Under divisions	White...	28·39 per cent.
	Black, with food, etc.	25·05 ,, ,,

The balance is for various supplies, of which the principal are:—

Explosives	10·95 per cent.
Fuel	8·23 ,, ,,

The dominating importance of the Labour Factor, viewed simply from the working cost basis, is thus at once apparent, and the right consideration and solution of it is not only the main question for the mines, but also seems to be vital for the advancement and prosperity of the whole of South Africa. A right adjustment will make for prosperity both industrially and politically.

The total population of South Africa south of the Zambesi has been estimated at 6,000,000, of which only 1,000,000 are whites. On distribution this would only figure out at between four and five per square mile for both races. (Some statisticians state that the average on this basis for the whole world is twenty-eight. The native races have not, as in some countries, been swept away by contact with civilisation, but under British protection they increase and multiply exceedingly; they have shown capacity to even survive the vices of the white man. Thus the existence of these black races must

be taken into account, whether we think it a good thing for the country to be wholly a white man's country or not, because they are there to stay and breed as fast as any of the European races.

The necessity of rigidly defining white and black work at the mine is apparent. The only possible way to bring about (even in time) a condition of affairs in which the white man could undertake to do all labour connected with the mines, under a set of conditions even approximately similar to those prevailing in Europe, would be by the rigid exclusion of every native from the area of the fields, no matter what his mission or occupation. Is this practicable or desirable in view of the impossibility of extending the system throughout this and the adjoining Colonies, and the high living costs prevailing among the white population ?

IMPROVED MECHANICAL DEVICES.

With the moderate grade of the ore on these fields, the rate of wages paid to white labour has been possible or justifiable only by :—

(1) The extensive scale of operations which has been adopted, the expenditure of an immense amount of capital for equipment and improvements, and the liberal use of improved mechanical devices ;

(2) Regarding the native races employed as merely muscular machines, and paying them much lower wages than the whites.

With regard to the first point : It has been the aim of the engineer in South Africa to use machinery and labour-saving devices to a greater extent than has ever before been employed in gold-mining. That this is so is, on the whole, frankly admitted by engineers from other parts of the world. In certain special details it might be questioned, especially in connection with underground transportation ; but here the nature of the deposit must be taken into consideration, and the small average tonnage obtained from the stripment of a unit area of the reef. The smaller this amount, and the lower the cost of muscular labour, the less is the justification for capital outlay in this respect.

With reference to the excellence of the machinery connected with crushing, and the number of tons crushed per stamp, comparison need not be feared.

The general surface equipment of the mines includes in most instances machines of the best design and highest duty of their class, whether this refers to prime movers, electrical generating plants, or air compressors. In connection with this last, it may be of interest to mention that the State mining engineer reported in 1898 that there were in operation during that year, on an average, 1,850 air-operated machine drills, which, as they use, at a very moderate estimate, 10 h.p. per drill, is equivalent to the utilisation of 18,500 h.p. to supplement human muscle in this department of work. Strenuous endeavours have been made in the past, and will continue to be made, to extend labour saving appliances in substitution, wholly or in part, of the native drill boy. So far the efforts have been either a failure or, at best, have met with only partial success, owing to the difficulties of fulfilling the required conditions of efficiency and cheapness.

The extension of the principle of mechanically operated devices for transport forms part of the general economic policy in connection with the equipment and working of these mines, and on every hand may be seen systems of steam or electrically operated transporting mediums, consisting of wire haulages, belt conveyors and locomotive ways, devised to economise the labour force and bill.

In the treatment of the sands by the cyanide process, mechanical skill has effectively created a combination of arrangement by which full use is made of the action of gravity in the transference of charge from one tank to another, thus minimising the employment of human labour.

It is not claimed that all possible means of elucidating the labour problem by the application of mechanical devices have been exhausted ; on the contrary, the necessity for still greater effort is fully realised, and it is frankly acknowledged that, in the matter of haulage, both under and overground, there is scope for still greater improvement. But it may be confidently affirmed that nowhere in the world, in metalliferous mines with a thickness of deposit similar to the Rand, are labour-saving devices employed to a greater, or even to the same, extent ; nor is there record of a thin reef deposit being worked in a more energetic manner or on a greater scale, and on this account it has been possible to employ a great amount of white labour on a class of mechanical work which requires a higher grade of intelligence than is developed in the native.

WHITE LABOUR CANNOT TAKE THE PLACE OF BLACK.

Where the experiment has been made in departmental work of replacing native workers by unskilled whites, the consensus of opinion among the managers is that it has been costly and unsatisfactory ; costly, as on an average the work performed has varied from a maximum of one white to two natives to a minimum of one white to less than one native, and the pay in the ratio of say 10s. for the former to about 2s. for the latter per shift.

The experiment has been *unsatisfactory*—as the skilled white men have been unsettled, are fearful of reduction in their pay, and have agitated ; and the unskilled men are also dissatisfied from the fact that the remuneration they receive is much less in comparison to their work than that given to the skilled men. Their stay at the mines has generally been short, and their work as a whole has not been favourably reported on by the managers.

As a mere muscular machine the best developed native, when he has remained long enough at the mines to be thoroughly trained, is the equal of the white man. The brain and industrial training are the white's own superiority. In classes of work into which brain power does not enter, or enters only to a limited extent, it is hopeless to seriously consider, from an economical standpoint, the substitution of a mere muscular machine costing 20s., or even 10s., a day for one costing up to 2s. or even 3s. per day and capable of developing the same energy.

To obtain the maximum population, intelligence, and contentment, work among the whites must be confined to skilled departments where brain tells, and the mere muscular work apportioned to races willing to be considered inferior, and to work cheerfully for wages far

COMPARISON OF
AVERAGE RATES OF PAY IN THE TRANSVAAL AND IN OTHER COUNTRIES.

COUNTRIES AND MINES	NATURE OF MINING	GENERAL MANAGER	UNDERGROUND MINE MANAGER	SECRETARY	MECHANICAL ENGINEER	MILLMEN	CYANIDERS	ASSAYERS	SURVEYORS	ENGINE DRIVERS	CARPENTERS	SMITHS	SHIFT BOSSES	MINERS	TRUCKERS	LABOURERS	FITTERS	STOKERS	ROCK DRILLS	MISCELLANEOUS WORKERS
		p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem	p m p diem
AUSTRALIA & NEW ZEALAND																				
WEST AUSTRALIA	Gold	£ [illegible]	£ 25 / £ 45	£ 30 / £ 55	£ 35 / £ 50	£ 20 / £ 30	£ 25 / £ 65	£ 20 / £ 30	£ 25 / £ 35	15/	16/	15/	16/8	14/6	10/	10/				
VICTORIA		[illegible]	£ [illegible] / £ [illegible]	£ 6 / £ [illegible]8	£ 20 / £ 40	£ 12 / £ 16	£ 20 / £ 25	£ 12 / £ 16		9/6	10/ / 12/6	10/-	9/6	7/	5/-	6/6				
NEW ZEALAND		£ [illegible] / £ 40	£ 15 / £ 25	£ 12						8/ / 10/	8/ / 10/6	8/ / 10/6		7/- / 10/		6/- / 8/-		6/6 / 8/6		
UNITED STATES AMERICA																				
ALASKA TREADWELL						£ 20 / 16/8						16/8		10/5		8/4	16/8		10/3 / 12/6	
DEADWOOD TERR.						12/6					14/6			12/6	10/6		10/6			
HOMESTAKE						14/6					16/8			14/6	12/8		12/6			
UTAH			£ 20 / £ 30	£ 15 / £ [illegible]		£ 18 / £ 60 10/ / 15	£ 18 / £ 60 10/ / 14	£ 15 / £ 35						8/6 / 15/		8/ / 8/4	10/ / 16/4	5/10 / 8/6		
ARIZONA			£ 25 & over	£ 15 & over		£ 25 & over [illegible]	£ 20 & over 10/ / 14	£ 15 / £ 35						[illegible] / 8		10	15/ / 16/8	[illegible]		
N MEXICO & S CALIFORNIA			do	do		£ 25 & over do	do do	£ 15 / £ 25						do		do	do	do		
PRUSSIA																				
OBERSCHLESIEN	Coal													3/6	3/6	1/8 / 2/				3/
DORTMUND														3/-		2/3 / 3/3				3/6
HALLE	Copper													3/6	3/6	[illegible]				3/
OBERHARZ	Ore Mines													2/9	2/9	[illegible]				2/9
TRANSVAAL																				
WITWATERSRAND		£ 13/13/5	£ 46/1/3	£ 30/6/5	£ 43/4/10	£ 22/1/10	£ 24/2/10	£ 23/5/4	£ 30/8/8	£ 26/2/6	£ 25/2/5	£ 26/9/1	£ 32/3/8	£ 22/1/1	£ 22/1/1	£ 17/9/2	£ 26/5/2	£ 29/3/2	£ 30/[illegible]	£ 20/4/1
ENGLAND & WALES																				
MIDLANDS														6/-		4/-				
SOUTH WALES														6/8		3/6	Including Rent		10d p D	
NORTH LANCASHIRE														6/6		4/				
INDIA			£ 22 / 30		£ 10 / 4	[illegible] £ 6 / 40 £ 11 / 15	£ 20 / 30			£ 5	English [illegible] £ 13 / 14 £ [illegible]	£ 18 / 23		£ 16 / 17	£ 6 / 17		£ 10 / 20		£ 6 / 8 [illegible]	

(FROM THE ANNEXURE TO THE THIRTEENTH REPORT OF THE TRANSVAAL CHAMBER OF MINES.)

STATEMENT SHEWING AVERAGE PERCENTAGE OF VARIOUS ITEMS OF COST IN THE TOTAL WORKING COST IN THE YEAR 1898.

GROUP		NO OF CO S	SALARIES AND WAGES WHITES	NATIVE WAGES	NATIVE FOOD	COST OF PROCURING NATIVE LABOUR	EXPLOSIVES	FUEL	MINING TIMBER DEALS ETC	IRON STEEL TOOLS ROPES SHOES DIES LUBRICANTS CANDLES PARAFFIN	CHEMICALS	ANIMAL FOOD	SUNDRIES	TOTAL
CONSOLIDATED GOLDFIELDS	PRODUCING MINES	2	27·52	16·69	4·51	2·32	13·70	9·39	1·20	5·30	1·64	·22	17·61	100
	NON-PRODUCING MINES	5	29·54	23·82	5·87	·40	8·13	5·13	12·48	7·30	-	·23	6·10	100
H ECKSTEIN & Co	PRODUCING MINES	11	31·03	15·71	3·42	1·79	9·20	7·36	1·54	6·50	2·45	·37	20·63	100
	NON-PRODUCING MINES	2	9·52	4·48	1·02	1·66	·95	·31	8·48	2·89		·04	70·66	100
FARRAR & ANGLO-FRENCH	PRODUCING MINES	3	23·08	17·61	5·14	3·88	12·48	4·69	1·61	10·30	2·18	·27	18·86	100
	NON-PRODUCING MINES	2	23·86	14·34	2·72	0·48	8·35	4·55	2·58	6·08	0·13	·35	36·66	100
GENERAL MINING & FINANCE	PRODUCING MINES	3	31·58	21·89	3·57	-	8·54	8·35	1·72	10·34	4·26	·33	9·43	100
	NON-PRODUCING MINES	-	-	-	-	-	-	-	-	-	-	-	-	-
A GOERZ & Co	PRODUCING MINES	3	24·14	19·18	4·41	1·35	12·65	8·30	0·69	11·87	1·34	·22	15·85	100
	NON-PRODUCING MINES	1	30·70	23·10	4·40	-	12·40	7·70	5·30	-	-	-	16·40	100
J'BURG CON INVEST Co	PRODUCING MINES	9	24·75	21·33	4·30	2·46	10·21	9·42	4·32	3·71	1·32	·21	17·07	100
	NON-PRODUCING MINES	-	-	-	-	-	-	-	-	-	-	-	-	-
S NEUMANN & Co	PRODUCING MINES	3	26·92	21·04	3·55	1·64	11·91	8·67	·64	7·09	3·07	·42	16·15	100
	NON-PRODUCING MINES	4	34·35	20·28	3·48	0·81	9·06	11·02	7·76	6·91	·06	·52	6·75	100
RAND MINES	PRODUCING MINES	8	35·26	14·12	3·36	4·08	12·64	8·37	1·15	4·58	3·94	·30	12·20	100
	NON-PRODUCING MINES	1	24·48	8·68	2·05	1·09	3·79	3·78	10·79	3·21	·09	·25	41·7[illegible]	100
J B ROBINSON	PRODUCING MINES	7	31·11	14·45	3·80	5·85	7·22	8·45	1·91	9·17	4·11	·50	13·43	100
	NON-PRODUCING MINES	-	-	-	-	-	-	-	-		-	-	-	-
SUNDRY	PRODUCING MINES	9	28·47	23·52	4·46	0·90	10·93	9·29	1·33	9·46	2·39	·40	8·[illegible]6	100
	NON-PRODUCING MINES	2	42·08	16·73	3·33	1·07	6·97	17·38	·74	7·11	·11	·07	4·41	100

(FROM THE ANNEXURE TO THE THIRTEENTH REPORT OF THE TRANSVAAL CHAMBER OF MINES.)

below the scale required by the white population to support their families in the condition of affairs obtaining in this country at the present time, or to be expected in the immediate future.

It seems that no other conclusion can be drawn than that, under existing conditions on these fields, the continuance and expansion of the mines, and the prosperity, contentment, and existence of the white population depend, in a large measure, on an adequate supplementary supply of cheap labour through the medium of coloured races.

The present condition of affairs is briefly: In 1899 there were employed at the gold and coal mines in the Transvaal, say, 100,000 natives.

At the end of May, 1902 37,000
" November, 1902 ... 48,000

To return to the same conditions as obtained before the war some 52,000 more natives are required.

The recruiting by the Witwatersrand Native Labour Association, in spite of reasonable expectations of success, has been at times particularly disappointing. Its chief utility is to prevent wasteful competition among the different mines in obtaining their natives; and it also protects natives against unkind and unjust treatment on their journeys, or unfairness in promises made to them. The Native Labour Association also, in a measure, artificially adjusts the discrepancy between supply and demand.

CAUSES FOR SHORTAGE OF NATIVE SUPPLY.

The causes that have been assigned for the present distressing shortage of native supply are :—

(1) The War.
- (a) During its progress the native obtained employment at high rates of pay, and made large accumulations of cash and property without being subjected to taxation.
- (b Subsequent to the Declaration of Peace, a great demand arose for labour to repair damages and to revive and extend all classes of industrial and agricultural enterprises; thus engendering excessive and competitive demand for his services at an increased rate of wages, the mines here alone making an effort to reduce the pre-war rate of pay.

(2) Abundant harvests.
(3) Insufficient pressure on the native to make him labour proportionately to the white man.
(4) Reduction in the Schedule of native wages.

POSSIBLE REMEDIES.

There is no good to be gained by dwelling too much on mistakes of the past, or by looking too pessimistically on the possibilities of the future.

We are all in accord in our belief that the native of South Africa is an excellent and powerful muscular machine, and, if he can be obtained in sufficient numbers, and induced to remain on the mines for extended periods, we do not desire to look further afield; but the fact is we are alarmingly short of the complement required to run the existing mines.

For expansive prosperity, whether from the aspect of the shareholders in the mines, or the white employees thereof, we believe that an abundant supply of cheap labour drawn from the coloured races is of supreme importance, and without this aid there do not appear to be any great potentialities for the shareholder, the white mine employee, or the country at large.

The burning question is how this vital factor in the general prosperity can be provided as the mining industry demands. The only remedies seem to be :—

(1) More legal and moral pressure to compel a greater number of natives in British Possessions to work, and for longer periods. It is gratifying to note that steps in this direction are being undertaken, not only for the benefit of the mines, but for all the industries of South Africa.
(2) To extend the present recruiting area with the utmost vigour, and to give not only money inducements, but consideration and care to natives from more distant districts.
(3) Importation of Asiatics.

We consider that No. 3 should be undertaken as a last resource, and under most stringent Government control.

SPECIAL COMMISSIONER'S REPORT.

The report of Mr. Ross Skinner, the Commissioner appointed by the Johannesburg Chamber of Mines to inquire into the question of procuring Asiatic labour for the Rand, is the outcome of a tour which has been made through California, British Columbia, Japan, the Malay States, and the coast of China between Hong-Kong and Tien-tsin, afterwards returning to England by way of the Great Siberian Railway. Mr. Skinner says he considers that the better class of Chinese labourers are quite suited to supplement the present Kaffir labour in the mines. He believes that a sufficient number of coolies is obtainable to meet the requirements of the Rand in the present and the immediate future. With regard to recruiting, Mr. Skinner concludes that if the reports from the first batch of Chinese labourers should prove favourable it would only be a matter of months before Chinese labour would begin to affect very appreciably the gold production of the Transvaal. Mr. Skinner never lost sight of the serious undertaking involved in bringing into the country a large number of aliens whose civilisation and manner of living are entirely at variance with those of the present population. He urges that, while making use of the proposed Asiatic labour to surmount present difficulties, the policy would be to augment the numbers of Kaffirs employed by every means possible, looking forward to the time when South Africa should be able to supply its own requirements in the matter of native labour. The introduction of Chinese, under strict sanitary regulations, and confined to their own mines and areas, would be productive of good by allowing the present mines to be re-worked and new properties to be developed, thereby creating an opening for whites. Chinese labourers, says the report, would not affect the price of skilled labour, but on the contrary would provide more opportunities for such labour. The report recommends that as an incentive to recruiting, if Chinese labour proved successful, the Chinese should be allowed to bring their families, which would also be repatriated on the expiration of their indentures. Mr. Skinner anticipates that the attitude of the Chinese Government would be entirely passive.

The impression of mining men is reported to be generally favourable to the report, although they realise that no recruiting in the Far East will be possible before the necessary legislation is enacted. The Labour Commission has concluded its inquiry, and should publish its report by the time these lines are in print.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

Telephone No: 3340 GERRARD

Telegraphic and Cable Address: "SINEWY, LONDON."

Editorial.—*All communications intended for publication should be written on one side of the paper only, and addressed to "The Editor."*

Any contributions offered, as likely to interest either home or foreign readers, dealing with the industries covered by the Magazine, should be accompanied by stamped and addressed envelope for the return of the MSS. if rejected. When payment is desired this fact should be stated, and the full name and address of the writer should appear on the MSS.

The copyright of any article appearing is vested in the proprietors of PAGE'S MAGAZINE *in the absence of any written agreement to the contrary.*

Correspondence *is invited from any person upon subjects of interest to the engineering community. In all cases this must be accompanied by full name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

The Editor does not hold himself responsible for the opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Subscription Rates per Year.

Great Britain—In advance, 12s. for twelve months, post free. Sample Copies, 1s. 4d., post free.

Foreign and Colonial Subscriptions, 16s. for twelve months, post free. Sample Copies, 1s. 6d. post free.

Remittances should be made payable to PAGE'S MAGAZINE and may be forwarded by Cheque, Money Order, Draft, Post Office Order, or Registered Letter. Cheques should be crossed "LONDON & COUNTY BANK, Covent Garden Branch." P.O.'s and P.O.O.'s to be made payable at East Strand Post Office, London, W.C. When a change of address is notified, both the new and old addresses should be given. All orders must be accompanied by remittance, and no subscription will be continued after expiration, unless by special arrangement. Subscribers are requested to give information of any irregularity in receiving the Magazine.

Advertising Rates.

All inquiries regarding Advertisements should be directed to "THE ADVERTISEMENT MANAGER, Clun House, Surrey Street, Strand, London, W.C."

Copy for Advertisements

should be forwarded on or before the 3rd of each month preceding date of publication.

The whole of the contents of this publication are copyright, and full rights are reserved.

OUR MONTHLY SUMMARY.

LONDON, October 20th, 1903.

South African Labour.

At the time of writing, we are still awaiting with interest, the report of the South African Labour Commission, but it appears pretty evident, from the general trend of events, that our new Colonies will have to seek the aid of John Chinaman. Lord Milner's most recent pronouncement on the subject was significant.

"In the first instance we must await the result of an exhaustive inquiry. If that inquiry shows a certain course—which in itself is disagreeable to all of us, British and Dutch alike—to be necessary, we must face it like men, taking care that the imported labour, which we do not desire, but may have to have, is so controlled as to inflict no injury to the country.

"That is my policy, to dispense with Asiatic labour if we can, to introduce it if we must, under a law which will provide for the return of the labourers at the expiry of their period of indenture, and not to remain here as traders or landowners, or even lessees of land. They come for labour, and can remain for nothing else."

Many of the more important facts underlying this question, are summarised in the previous pages. Though at the time of writing there has been a distinct recovery in the prices of South African Mining Shares, after a long period of cumulative depression, there can be no question that South African Mines have been most seriously affected by the widespread scarcity of labour. Railway enterprise in the new Colonies has also been impeded, and everything points to the necessity for some drastic step to bring about an alteration in the existing condition of affairs. Under the circumstances, it is difficult to see how the importation of Chinese labour can be avoided.

Mr. Ross Skinner, the commissioner appointed by the Johannesburg Chamber of Mines, says emphatically that in his opinion the better class of Chinese labourers are quite suited to supplement present Kaffir labour in the mines. The members of the various scientific and technical societies of the Rand, have also passed a resolution, expressing their conviction that the permanent employment of large numbers of unskilled white labourers is too expensive, and that there is no present indication that the demand for unskilled labour can be materially reduced by the further adoption of labour-saving devices. They are, therefore, strongly of the opinion that immediate steps should be taken for the introduction of unskilled Chinese or other coloured labourers under proper restrictions for their importation, employment and repatriation. Should the decision of the Commission be in a line with this view, the necessary legislative enactments would of course take time, but a practical step will have been taken towards the solution of what at one time seemed an overwhelming difficulty.

The Second Mosely Commission.

Since we last went to press the second Mosely Commission has commenced its work in America—a fitting corollary to that of the Industrial Commission. The widely differing conditions affecting education in this country and the United States are well known, and it may be remembered that the members of the Industrial Commission showed a wide division of opinion as to the relative merits of technical instruction in England and America. While it is probable that many of their methods are entirely unsuited to the

needs of this country, it is impossible to suppose that the able men composing the Commission can return without acquiring valuable experience, more especially in the direction of organisation. Moreover, the Commission enters upon its work at a particularly opportune time.

According to the *Times* special correspondent the original programme has, after consultation with and under the advice of Principal Murray Butler, of Columbia University, been somewhat modified. Ten days were given to New York as furnishing typical examples of every kind of educational development and the most thoroughly organised system of public education in the United States. The programme then provided for two days at Washington, and a reception by President Roosevelt, a few hours being spent at Baltimore in order to inspect the John Hopkins University. Three days were set apart for Philadelphia, a night being spent at New Haven for a visit to Yale University. Four days at Boston were to be followed by the best part of a week devoted to Chicago and the more prominent State Universities.

The question of technical education as developed in America opens up a long story. Mr. J. F. Fraser, in his work on America, has shown the importance which the Centennial Exhibition of Philadelphia in 1876 had upon the rise of technical education in that country. It opened American eyes to what Europe was doing, "and when American eyes are opened it is to imitate, and not merely to admire." Mr. Fraser remarks that "manual training schools flourish everywhere, not so much to teach trades as to give general instruction in the principles of various trades. The whole trend of instruction in the public schools, in what we call the secondary schools, and in the universities, is not to give academic studies, but something practical that will be useful in a commercial career." He also emphasises the prominent interest displayed in the movement by American manufacturers. "Lads who have gone through a university training successfully are snapped up at once by employers. It is not an unusual thing for the chief of a great manufacturing firm to write to the head of the mechanical department of a university: 'I will take fifty of your students in mechanics who finish their course this year.'"

Among the members of the Industrial Commission it was widely felt that education was more liberally considered by employers in America than in this country, and Mr. R. M. Walmsley, the principal of Northampton Institute, who has already made an independent investigation of the educational methods employed in America, is also emphatic on this point. "The schools," he says, "are numerous, well equipped, and fairly well staffed, and their curricula, on the whole, are well adapted to the requirements of the profession; and the employers and manufacturers are convinced of the importance of the training given in the schools, and, for the present, are willing and able to find places for and to give a fair chance to every graduate turned out, and also to render assistance to the schools by the free gift of machinery and apparatus, and in other ways."

Manufacturers and Technical Education.

Evidences are not wanting, however, that English manufacturers are becoming keenly alive to the value of technical education. In another part of the MAGAZINE will be found a brief account of a successful scheme, which has been introduced by Messrs. Richardsons, Westgarth and Co., Ltd., at Hartlepool, for the encouragement of their engineering apprentices. Some time ago we called attention to the efforts which are being made by Messrs. Handyside, of Derby, to enable their apprentices to attend classes in the district. Another instance is offered by Palmers' Shipbuilding and Iron Company, in which the management is endeavouring to persuade their engineering apprentices to take more interest in technical classes, and has offered them inducements in the shape of increased pay and admission to the drawing office. Yet another effort in this direction is that which is being made by the Education Committee of the Borough of Swindon to provide in a complete manner for the technical instruction of Great Western Railway apprentices. This has received the very greatest encouragement and assistance from the company and its officials. The Committee consider that it possesses all the elements of success, and that it will prove highly beneficial to the cause of technical education generally, and to the Great Western Railway and their apprentices in particular. Projects of this kind do much to show that British manufacturers, so far from being indifferent to technical education, are very much alive to the necessity of encouraging their apprentices in every possible way.

The Student's Part.

It must not be forgotten that the onus lies largely with the student. Our educational organisation may be in parts defective, but we should neither underrate it nor forget that to-day there is a clear way provided for students from the bottom rung of the ladder. Moreover, in these days students are treated entirely on their merits. For instance, only recently the Gloucestershire County Council Mining Scholarship of £100 for two years was won by a working collier named Sydney Thomas, of Bilson Green, Cinderford, Forest of Dean. This student, who has our congratulations, will receive two years' training under the care of the General Manager of Messrs. Pearson and Knowles Coal and Iron Company, Wigan, and is entitled to study at Wigan Mining and Technical College. The classes were held in four towns in the Forest of Dean, and of ninety-one students enrolled, the average attendance was eighty-one; of these sixty-nine entered for the prize. We were sufficiently curious to ask Mr. Thomas to state the causes to which he attributes his success. His reply is very much to the point. He says: The two chief reasons are (1) The excellent teaching of Mr. J. J. Joynes, Mining Lecturer to the County Council, and attending the lectures regularly; (2) working hard at the lessons while at home, and endeavouring to learn from the text books as much as possible. Since winning the Gloucestershire Scholarship, Mr. Thomas has been successful in gaining an Under-Manager's Certificate.

Armstrong-Whitworth Experimental Work.

The increasing value of experimental work was a theme which entered very largely into Sir Andrew Noble's address at the annual meeting of Sir W. G. Armstrong, Whitworth and Company, held at Elswick. In the Openshaw Armour Plate Works he thought they had the most improved armour-plate factory existing. The making of armour-plates being a very special work, the directors had thought it wise to write specially a very considerable depreciation off for armour-plate machinery. The provision for expenditure on experimental account was slightly reduced; but they had found it necessary to make during the past year, and would have to make for some time to come, a very considerable number of experiments; and perhaps there was no manufacturing business which required so much experiment as that with which their property had to deal.

They had also made a number of under-water discharge torpedo-tubes, and experiments had been carried out with these in Austria, Holland, and Sweden. A great number of experiments had been made with explosives for propelling the projectiles from guns, and with high explosives for shells. As to the experiments on mountings and gun-carriages, they would judge when he told them that during the past year gun-trials had been made for the following ships: The *Russell, Montagu, Lancaster, Duncan, Donegal, Cornwallis, Berwick*, and *Leviathan*.

The experiments which Mr. E. L. Orde had been carrying out with oil fuel were completed, and they had had some Admiralty officials down to see the results. He thought he might say that Mr. Orde had succeeded in obtaining better results with oil fuel, as to the absence of smoke—practically there was no smoke—than any other experimenter before him. The past year's work at Elswick included two coaling haulabouts for the British Admiralty, the repair of the cable-ship *Restorer*, the building of the Chilian line-of-battleship *Constitucion*, the building of the British cruiser *Hampshire*, and the building of the Turkish vessels *Abdul Hamid* and *Seughudlu*. Gun fitting and other work had been further carried on at Openshaw, and the Walker yard had launched eight merchant vessels.

The Effect of Dust in Mines.

Elsewhere we print an article by Mr. William Cullen on the effect of dust in mines. In connection therewith it is interesting to note the conclusions which have been arrived at by the Miners' Phthisis Commission. The cause of the disease is undoubtedly the inhalation of dust, and the recommendations of the Committee consequently amount to this: (1) Allay the dust as far as possible; (2) provide healthy conditions, *e.g.*, in ventilation, sanitation, and changing rooms. The most important recommendation of the Commission calls for systematic ventilation rendering it possible for fresh air to sweep through the drives and carry off all noxious gases and impurities. The Committee condemn the use of inferior lubricants for compressor air cylinders, and defective detonators. Sanitary precautions, which are necessary to prevent the spread of other diseases such as ankylostomiasis, are also recommended, and it is urged that change houses, suitably warmed and near each shaft, should be provided for miners.

Proposed Moving Platform System.

A novel proposal hails from New York, involving a development of the moving platform system, which it is suggested should be carried through a tunnel in that city and then across the Williamsburg Bridge, suitable connections being provided with the present subway and elevated railways. This plan has already been recommended for approval by the Extensions Committee of the New York Rapid Transit Commission, but before the actual construction is authorised the committee's plans will have to be approved by the Commission, passed by the Board of Aldermen and the Board of Estimate and Apportionment, and finally approved by the Appellate Division of the Supreme Court. This procedure having been carried out, bids open to all, will be asked for the construction of the subway. The tunnel in Manhattan will be divided into two sections by a partition, so that trains will run in but one direction in each. The tube itself will be little larger than those now being constructed for the subway. The wheels are not to be on the cars themselves, but are to be stationary. The rails, instead of the wheels, will "run." There are to be three platforms. A passenger getting aboard would step from the station platform on to the first, which is going one-third as fast as the third, whereon are the seats. Then he would step from the first to the second, going in the same direction, but a third again as fast as the first. From the second he would step to the third and last, which is to be made up of many short cars so closely joined together that they form a single train, thus rendering it difficult to see the separate sections. The seats are to be crosswise of the car, as at Chicago in 1893. They will be about three feet apart, and each will seat three persons comfortably. When a passenger approaches a station at which he wishes to get off, he steps from the third platform to the second, and sees the seat in which he sat speed on ahead. Then he steps to the first and finds himself hardly moving. When the station is reached he alights. It is estimated that when the platforms are moving at, say, nine miles an hour, and that is a fair average and one perfectly possible, the line could carry 47,520 an hour—nine times the 5,280 passengers in the mile. In the present plans for the tunnel and trains it is intended to use nothing inflammable except the wooden backs of the seats; and steel may be substituted for the wood even there when it comes to the construction. The dynamos and all of the wires are separated from the passenger tunnel by a thick wall of concrete.

Some Forthcoming Exhibitions and Meetings.

Judging by the number of things which are to be the "largest on earth" at the St. Louis Exhibition, it is wonderful that sufficient space can be found for them all. Glowing accounts of the progress of the works continue to reach us, however, and there can be no doubt but that the exhibition will have several surprises in store for the engineer.

In 1905 it is proposed to hold an International Exhibition at Manchester. The next tramway congress will be held early in September, 1904, in Vienna. The British Association meets next year at Cambridge, and in 1905 the Association holds its meeting in South Africa. The next autumn meeting of the Iron and Steel Institute will be held on October 24th, 25th, and 26th next year. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburg, Cleveland, Niagara Falls, and Buffalo, the members returning to New York on November 10th. Even Rio de Janeiro has been seized with the spirit of emulation which is abroad, and is likely to have an international steerable baloon competition in 1904, while an exhibition of agricultural products, implements, and machinery is to be held shortly at Lagos, in West Africa.

With the object of affording inventors and patentees an opportunity of bringing their inventions before the notice of capitalists, manufacturers, and users, an Inventions Exhibition is to be held at Brighton during the coming month under the control of the Mayor and Corporation. At a Gas Lighting, Heating, and Hygiene Exhibition at the Crystal Palace next month, prominence is to be given to smoke abatement inventions.

The doom of the Eiffel Tower, by the way, has been literally sealed, for the Municipal Committee of "Old Paris" has decreed that it is to be taken down in 1910 to make room for improvements.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

AT the time of writing the ever-recurring Far Eastern question is again under discussion, and in this connection much is being said and written about the relative strength of Russia and Japan in Far Eastern seas. Elaborate catalogues of ships and men have been published for this purpose, with the result that in respect of these two assets we are told there is very nearly an equality of power. I do not propose to criticise this conclusion, but merely to insist upon the essential necessity for further considering the quality I have referred to above The discipline in both navies is reported to be excellent, but it is maintained by methods and motives which widely differ. The intelligence of the Russian seaman is, observers tell us, far lower than that of the Japanese, and while the former renders obedience conformably to a stern and rigorous code of law, the other does this from a sense of duty and keen patriotism. It may be doubted, too, if in regard to the handling of the ships, to the efficiency of the machinery and to the training of the gunners, the standard is as high in the Russian Navy as it is in the Japanese. Moreover, we cannot forget that the latter have been tried by the test of war, whereas the former have no such experience.

In any attempt to form an estimate of the battleworthiness of modern fleets, we have for our guidance the struggles at sea which were severally decided at Lisa, the Yalu, and Santiago. It has been said that the result of these three battles would in all probability have been of a similar character had the combatants in each instance occupied and used the ships of their opponents. This is but to say that the intelligence, training, and character of the officers and men must remain the deciding factors in naval engagements where other things are reasonably well balanced. The conditions, however, in the event of a conflict between Russia and Japan are not closely comparable with those which obtained in the wars which furnish the only three examples of naval battles under modern conditions.

GREAT BRITAIN.

ADMINISTRATION.—So far as the principle of administering the Navy is concerned, no change has taken place during the past year. Sir Michael Culme-Seymour, Vice-Admiral of the United Kingdom, has, however, called in question the wisdom of retaining in force the arrangement provided by an Order in Council which gives the First Lord a position of pre-eminence which Sir Michael considers to be disadvantageous and likely to be dangerous. It may be pointed out, however, that the Patent appointing the Lords Commissioners of the Admiralty has the opposite and contradictory effect to the Order in Council referred to, and, as a matter of fact, so elastic are the powers under which the Board administer the Navy that it appears to matter little whether the Order in Council remains or not. So far as the personnel of the Board is concerned, the changes on the political side have been caused by the preferment of Mr. Arnold-Forster to the post of Secretary of State for War. His place as Secretary of the Admiralty has been filled by Mr. Pretyman, who was previously the Civil Lord, Mr. Pretyman in turn being succeeded by Mr. Lee. On the Naval side, Sir John Fisher has left the post of Second Sea Lord to become the Commander-in-Chief at Portsmouth, and he has been succeeded by Sir Charles Drury.

FINANCE.—The Navy Estimates for 1903-4 were £34,457,500, being an increase of £3,202,000 over the estimates of the previous year. This is the sum actually estimated as the cost of the Navy, including the non-effective services, but excluding other charges which fall under the estimates for the Civil Service and Revenue Department, which amount to about £300,000, and excluding also the cost of permanent works provided for under the Naval Works Bill. Out of the first-named sum, £10,136,430 is provision for new construction, which is £1,077,910 more than the sum voted for this purpose last year.

PERSONNEL.—The number of officers, seamen, boys, and marines, and others provided for sea and other services amounts to 127,100, showing an increase of 4,600 on the previous year.

MATERIEL.—The strength in ships built, building, and projected on October 31st was :—

Built.	
Battleships, 1st class	47
do. 2nd class	4
do. 3rd class	2
Coast defence ships	2
Armoured cruisers	24
Protected cruisers, 1st class	21
do. do. 2nd class	51
do. do. 3rd class	32
Unprotected cruisers	10
Torpedo vessels	34
Torpedo-boat destroyers	112
Torpedo-boats	85
Submarines	9
Building.	
Battleships, 1st class	7
Armoured cruisers	13
Protected cruisers, 2nd class	2
do. do. 3rd class	4
Scouts	4
Torpedo-boat destroyers	19
Torpedo-boats	5
Projected.	
Battleships, 1st class	6
Armoured cruisers	4
Protected cruisers	3
Scouts	4
Torpedo-boat destroyers	15
Submarines	10

These tables are founded on the official return published in May last. They differ in some particulars, however, the battleships built being now five more in number than they were then. These five vessels are the *Duncan*, *Albemarle*, *Russell*, *Exmouth*, and *Montagu*. Six armoured cruisers have also been completed, the *Euryalus*, *Monmouth*, *Kent*, *Essex*, *Donegal*, and *Bedford*.

All the vessels given in the projected list, except three battleships, belong to the programme of 1903-4, these three battleships being vessels which Mr. Arnold-Forster announced in the House of Commons are to be laid down at each of the three principal dockyards in April next.

FRANCE.

ADMINISTRATION.—At the French Ministry of Marine, M. Pelletan has remained in power all the year, despite

adverse criticism. Indeed, the Superior Council as a whole has not escaped the charge of incompetency, and the programme for this year, in which no battleships were included, and only one armoured cruiser was proposed, has come in for very severe comment.

FINANCE.—The Navy Estimates for 1903 totalled 306,692,678 francs (£12,267,630), as against 306,798,738 francs (£12,271,949) for the previous year. The total amount devoted to new construction was 89,100,000 francs (£3,564,000).

PERSONNEL.—The number of men on the active list of the French Navy during 1903 was 45,312, and the number of officers and men, 53,247. In the Reserve there were 49,346 officers and men. The number of men effective during 1903 is less by 2,940 than the number available in the previous year.

MATERIEL.—The strength of ships built, building and projected on October 31st was :—

Built.	
Battleships, 1st class	20
do. 2nd class	9
do. 3rd class	1
Coast defence vessels	14
Armoured cruisers	10
Protected cruisers, 1st class	7
do. do. 2nd class	16
do. do. 3rd class	17
Unprotected cruisers	1
Torpedo vessels	16
Torpedo-boat destroyers	14
Torpedo-boats	247
Submarines	15
Building.	
Battleships, 1st class	6
Armoured cruisers	11
Torpedo-boat destroyers	23
Torpedo-boats	43
Submarines	43
Projected.	
Armoured cruisers	2

In the above lists since the official return was published the battleship *Suffren* has been added to the completed list of first-class battleships, and the *Henri IV.* to that of the second-class vessels. Of armoured cruisers the *Dupetit Thouars* has been completed, and the *Jurien de la Graviere*, protected cruiser, has also been put in commission. The projected armoured cruisers are the *Jules Michelet*, which is to be laid down at Lorient in the coming spring, and *C* 16, which is to be of the *Ernest Renan* type, and will be built at Brest.

As we go to press a report from Paris fixes the proposed estimate for the Navy for 1904 at 312,931,832 francs, of which it is proposed to devote 113,712,127 francs to new constructions and the completion of the old programme.

GERMANY.

FINANCE.—The Navy Estimates for 1903 totalled £10,887,182, which was £853,208 more than that for the previous year. The sum to be devoted to new shipbuilding was £3,640,483.

PERSONNEL.—The number of officers and men on the active list is 33,542, and on the regular reserve there are 5,114. In all, however, there are about 70,000 men liable for service in the Reserve. For 1904 the personnel has been fixed at 38,000 of all ranks.

MATERIEL.—The strength of ships built and building on October 31st was :—

Built.	
Battleships, 1st class	13
do. 2nd class	4
do. 3rd class	12
Coast defence ships	11
Armoured cruisers	2
Protected cruisers, 1st class	1
do. do. 2nd class	[illegible]
do. do. 3rd class	10
Unprotected cruisers	20
Torpedo vessels	2
Torpedo-boat destroyers	32
Torpedo-boats	93
Submarines	—
Building.	
Battleships, 1st class	7
Armoured cruisers	4
Protected cruisers, 3rd class	7
Torpedo-boat destroyers	6
Torpedo-boats	—

RUSSIA.

ADMINISTRATION.—The death of Vice-Admiral Tyrtoff left the post of Minister of Marine open, and to that post the former Chief of the General Staff, Vice-Admiral Avelan, succeeded, by an Imperial decree of April 19th, 1903. The position which Admiral Avelan vacates is filled by Rear-Admiral Roschestvenski.

FINANCE.—The Estimates for 1903 amounted to 104,417,791 roubles (£10,876,853), showing an increase of 6,338,802 roubles (£660,292) over the estimates for last year. The sum devoted to new construction totalled 40,449,682 roubles

PERSONNEL.—The number of effective officers and men during 1903 was 64,416, the officers alone numbering 2,900. In the Reserve there were about 30,000.

MATERIEL.—The strength of ships built, building and projected on October 31st was :—

Built.	
Battleships, 1st class	15
do. 2nd class	4
do. 3rd class	1
Coast defence ships	13
Armoured cruisers	8
Protected cruisers, 1st class	6
do. do. 2nd class	5
do. do. 3rd class	—
Unprotected cruisers	3
Torpedo vessels	9
Torpedo-boat destroyers	4[illegible]
Torpedo-boats	102
Submarines	4
Building.	
Battleships, 1st class	8
Protected cruisers, 1st class	1
do. do. 2nd class	2
Torpedo-boat destroyers	7
Torpedo boats	7
Submarines	2
Projected.	
Battleships, 1st class	3
Armoured cruisers	3
Protected	2

Since the official table was published two battleships, the *Osslabia* and the *Tsarevitch*, have been completeds.

JAPAN.

FINANCE.—The Naval Estimates for 1903 totalled £2,885,000, but of this not a large proportion was taken for new construction, the new shipbuilding programme not coming into force until 1904.

PERSONNEL.—The Japanese personnel available for active service numbers about 31,000, and there is a small reserve of about 4,000.

MATERIEL.—The strength in ships built, building and projected is given in the following table :—

Built.

Battleships, 1st class	6
Do. 2nd class	1
Coast defence ships	2
Armoured cruisers	6
Protected cruisers 2nd class	10
Do. do. 3rd class	8
Unprotected cruisers	9
Torpedo vessels	1
Torpedo-boat destroyers	17
Torpedo boats	67

Building.

Protected cruisers, 2nd class	2
Do. do. 3rd class	
Torpedo-boat destroyers	2
Torpedo-boats	18

Projected.

Battleships, 1st class	4
Armoured cruisers	6

And some small craft.

ITALY.

FINANCE.—The total of the Navy Estimates for the year 1903-4 is 127,181,734 lire (£4,710,430), against 127,165,964 lire (£4,709,848) for the previous year, showing an increase of £582. The expenditure on new construction is to be £193,575.

PERSONNEL.—The effective list for the year 1903-4 totals 26,948 officers and men, and there is a reserve of 33,667 officers and men, but this latter is of doubtful efficiency, as many of the officers are over sixty-five years of age, and the men are only slightly trained.

MATERIEL.—The strength of ships built, building, or projected on October 31st, was :—

Built.

Battleships, 1st class	12
do. 3rd class	5
Armoured cruisers	5
Protected cruisers, 2nd class	5
do. do. 3rd class	11
Torpedo vessels	14
Torpedo-boat destroyers	11
Torpedo-boats	145
Submarines	1

Building.

Battleships, 1st class	6
Armoured cruisers	1
Submarines	1

Projected.

Battleships, 2nd class	3
Protected cruisers, 3rd class	1
Torpedo-boat destroyers	2
Torpedo-boats	8
Submarines	2

The vessels projected are those of the programme 1903-4. The three battleships are to be of a rather smaller type than the *Vittorio Emanuele*, and are possibly the three vessels which it was stated last year were to be known as the *Duke of Abbruzzi*, *Duke of Aosta*, and *Duke of Genoa*. The small cruiser will displace 3,500 tons, and will be of the *Puglia* class. Of the torpedo-boats, four will be built by contract, and four in the dockyards, while the destroyers are to be built by Pattison, of Naples. The submarines are designed, but no contracts have been entered into for them.

AUSTRIA-HUNGARY.

FINANCE.—The Estimates for 1903 totalled 48,990,920 kronen (£2,041,295), of which one-third belonged to the Extraordinary Budget. For new construction 22,298,810 kronen (£929,117) was voted.

PERSONNEL.—The personnel of the Austrian Navy numbers 10,841 of all ranks, but this includes the reserve.

MATERIEL.—The strength in ships built, building and projected on October 31st was :—

Built.

Battleships, 3rd class	5
Coast defence ships	3
River monitors	4
Armoured cruisers	1
Protected cruisers, 2nd class	2
Do. do. 3rd class	4
Torpedo vessels	15
Torpedo-boats	37

Building.

Battleships, 1st class	4
Monitors	2
Armoured cruisers	1
Torpedo vessels	5

UNITED STATES.

ADMINISTRATION.—Rear-Admiral Melville has retired from the post of engineer-in-chief of the United States Navy, and has been succeeded by Rear-Admiral C. W. Rae, and Rear-Admiral Bradford has been succeeded by Captain Converse in the Bureau of Equipment.

FINANCE.—The Naval Appropriation Bill for the year 1904 came to a total of £16,243,380, which is £39,467 more than that for 1903. The sums for new construction totalled £5,224,625. The suggested estimates for the next year, which have been passed by Mr. Moody, amount to £21,139,837.

PERSONNEL.—The numbers of officers and men in the effective list of the Navy is 29,838, inclusive of 7,000 marines. A reserve is being formed, but is not yet in working order.

MATERIEL.—The strength of ships built, building and projected on October 31st was :—

Built.

Battleships, 1st class	11
,, 2nd class	1
Coast defence ships	15
Armoured cruisers	2
Protected cruisers, 1st class	3
Do. do. 2nd class	12
Do. do. 3rd class	2
Unprotected cruisers	11
Torpedo-boat destroyers	20
Torpedo-boats	27
Submarines	3

Building.

Battleships, 1st class	8
Coast defence ships	1
Armoured cruisers	11
Protected cruisers, 1st class	--
Do. do. 2nd class	5
Torpedo-boats	4
Submarines	5

Projected.

Battleships, 1st class	5
Armoured cruisers	2
Protected cruisers	—
Torpedo-boat destroyers	—
Torpedo boats	—

WORKSHOP PRACTICE.

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

NEW MILLING MACHINE.

A LARGE "universal plane" milling machine has been specially designed by Messrs. Kendel and Gent, of Manchester, for Messrs. W. Beardmore and Co., of Parkhead, Glasgow. This is capable of dealing with the heaviest class of marine and general work, crank webs, connecting rods, quadrants, pedestals, etc. As an example of what the machine can perform, it may be mentioned that two crank webs, each measuring 5 ft. 3 in. in length by 30 in. diameter over the boss and 12 in. deep, are placed one over the other, and both milled together at one setting in five hours. This machine is, however, not specially designed for crank webs alone, but is equally capable of dealing with all kinds of straight or irregular surfaces. The firm have also just completed two high-speed radial drilling and tapping machines, which are capable of drilling at the rate of 5 in. deep per minute with an inch diameter drill in steel on these machines, the power expended in doing this work being only 4½ h.p. against 9 h.p. in an ordinary radial drilling machine.

A WORKSHOP AFLOAT.

The huge floating workshop which has been constructed for the Natal Government has a complete plant for ship repairing. Among other appliances may be mentioned a screw-cutting gap lathe, by Messrs. Dean, Smith, and Grace, with 10-in. centres and 15-ft. bed, admitting 9 ft. 6 in. between centres, and 3 ft. 4 in. by 12 in. in the gap; a shaping machine, by Loudon Brothers, having a maximum stroke of 18 in. and a table 6 ft. long; a double-geared drilling and tapping machine made by Smith and Coventry; a 5-ft. radial drilling machine by Loudon Brothers; a 3-cwt. steam hammer on a special foundation, supplied by B. and S. Massey; a punching and shearing machine by James Bennie and Sons, capable of punching 1 in. holes in 1 in. steel plate, and shearing plates of the same thickness, angles, etc.; two fixed smith fires and a portable fire; a slab for levelling; a 3-in. pipe-screwing machine; and a 40-ton cantilever crane with a span of 40 ft., by Jos. Booth and Brothers. The tools are driven electrically by motors constructed by J. H. Holmes and Co.

NEW 3-ft. 6-in. RADIAL DRILLING MACHINE.

The elimination of cone drives in a large variety of machine tools is steadily being effected, and there is no doubt when the substitute is efficient, and not liable to get out of order nor to break down, there are great advantages to be gained by dispensing with cones. Messrs. William Asquith, Ltd., of Highroad Well Works, Halifax, have given great attention to this matter, and are now equipping several of their machines with speed boxes. They have also successfully applied this form of drive to their 3-ft. 6-in. radial drilling, boring, tapping and studding machine. By means of their improved gear box, twelve changes of cutting speed, accurately graded, can be obtained whilst the machine is running, by simply moving levers. The entire range of speeds is controlled from this gear box, and can be obtained in under thirty seconds. The machine is also fitted with a feed box, giving six changes of positive feed motion, which can be obtained instantly by simply pulling down a button. Other features of this machine are its great strength and rigidity, ease and rapidity of manipulation, accuracy, and adaptability for high speed running.

AUSTRALIAN FOUNDRY EXPERIENCES.

Some interesting details of Australian foundry practice were recently given by Mr. James Musgrove in the *Iron Trades Review*. Says Mr. Musgrove:—

"I only watched this department a limited time each year, and then manned it with my general employees who, like myself, were trained to work at all branches. As a consequence, the moulding skill I had at my disposal was not of the highest order, and I soon felt that a mechanical device to take the place of that skill would be of great value—something that would insure clean and proper partings; that would give runners of the right size and best position, and which, above all, would insure a perfect mechanical draw to the pattern. With this object, about ten years ago, I worked out a system of moulding, which, strange to say, is almost identical with the one in use at the great works of the Siemens and Halske Company, at Berlin. There is nothing original in the principles of the system. In fact, it is simply a combination of two systems devised and worked out in England more than a quarter of a century ago, namely, "Jobson blocks," described in the fifth division of Spon's "Dictionary of Engineering," and Woolnouch and Dehne's moulding machine described in Spretson's "Casting and Founding."

As worked out by myself, the machine consists of a base plate with two vertical hollow pillars bolted at ends. Inside these pillars are accurately fitted standards made to rise and fall nine inches. The upper half of these standards is turned to fit the hand at pillars, and the bottom half is square with rack teeth cut on one side. These racks gear with two small pinions keyed on a cross shaft, which is turned by a side lever, and thus rises and lowers the standards. On the top of each standard is fitted a bearing to take the trunnions of the pattern block frames. The frames for these pattern blocks (which take the place of the usual match plate) are cast from the moulding box patterns, with the addition of a strong central rib and trunnions on each end—these trunnions being turned to fit the standard bearings. The boxes as well as the frames, are planed on edge, and the pin holes are drilled and sockets tapped with a jig so as to secure absolute fit and interchange ability.

The pattern blocks are prepared as follows: The patterns are carefully arranged and bedded in the drag, the parting nicely smoothed and the runners cut with judgment. The patterns are then brushed over with oil; the block frame is put on and filled with plaster of Paris mixed to the right consistency. When set the patterns are removed, the plaster face smoothed of all sand, surface-dried and varnished with shellac. If there are core prints or sharp projections in the cope part of patterns, I mould these projections, and cast them in white metal with staples or bent rods mounted to afterwards secure them in the plaster. These parts, after being filled and polished, are put in their places in the drag pattern block, the latter being previously well oiled, the cope frame put on, and also fitted with plaster. When set and removed, it will bring with it the metal portion, forming a composite but solid cope pattern block. The blocks are then well dried and

varnished; the patterns are put in place in the drag block and secured with screw wires passing through the plaster. When placed on the machines they are ready for moulding.

I use the machines in pairs so as to complete the boxes at once. The procedure is as follows: The moulding box is placed on blocks and clamped, sand filled in, rammed and strickled off level with boxes (gate pins are cut just the depth of box). The whole is then turned over on the trunnions and lowered on to the table of machine. Set screws in bearings are then tightened, trunnions rapped a little with wooden mallet, clamps released, and then the pattern block is lifted by depressing the lever, ensuring an absolutely perfect draw. The box is then drawn out on the table which runs on side ends, dusted, and removed to the floor. In the cut the parts of plaster blocks are shown with the respective moulded boxes below. This particular block carries no less than fifteen separate patterns, and is provided with whirling gates. I have never been able to get the phenomenal results recorded in the journals, but these machines double the output over hand moulding, and give better results. They deal particularly well with patterns having irregular partings and with bevel wheels and pinions. There is one feature I have noticed in machine moulding. To get the best results the pattern block should be slightly higher in temperature than the moulding sand. If lower in temperature, moisture condenses, and clogging sets in, giving trouble in brushing and cleaning patterns. If the mould is too hot the sand crumbles, but there is a certain difference, about ten degrees, where there is no adhesion and the results are perfect.

CONDITIONS IN GERMAN WORKSHOPS.

Further articles contributed to the *Times* on industrial life in Germany discuss the actual conditions which at the present time obtain in German factories. These, as regards health and comfort, and efficient working are found to be excellent. It is gratifying to know that the German best in this direction is no better than our best. The correspondent incidentally says: "I have neither seen nor heard of anything quite equal in some respects to the best of the great Bradford mills, and we have many recently built factories and works of various kinds which cannot be surpassed. On the other hand, we have naturally a larger proportion of old establishments than a country whose industrial development is so much younger; and, though they have their old, dark, and dilapidated buildings, I have not discovered any so bad as our worst. I should say that the German average reaches a higher standard than our own. The Germans appear to have grasped the fact that work is better done in a good than in a bad light, and great care is taken to secure it. Ventilation is also well managed; I find a monotonous entry, 'Good light and air,' in my notes. But the most striking feature of German factories is their clean, orderly, and well-kept condition. These qualities seem to be universal, and they extend to the dirtiest and most untidy departments. The foundry is the severest test. It is usually a scene of dirt and disorder, unmitigated by any attempt to be tidy, and aggravated by an atmosphere heavy with smoke and gloom. The German foundries were a revelation to me; they are as clean and well kept and almost as light as any other shop. The remarkable order maintained is systematic, and in a large measure intended to promote the prevention of accidents; in most of our engineering shops there is no room, the place is congested, and manufactured or half-manufactured articles lie promiscuously about in all directions, blocking the fairway. The entire freedom from such disorderliness in German shops and workrooms undoubtedly conduces to efficiency as well as to safety; and it is secured chiefly through the habits of order inculcated into all alike—workmen, managers, and owners—by the military discipline they have all alike undergone Fencing of machinery, however, is less complete and costly than that which is required in most factory districts in England. With regard to the installation of machinery and workshop appliances, I can only say that German establishments are, generally speaking, quite up to the mark. They make use of electric power, automatic tools, and similar modern devices to as great an extent as anyone else. There is no hesitation in introducing innovations and no opposition on the part of the workpeople. Machinery and tools are procured from any country without regard to any consideration but suitability; but Germany is year by year becoming more self-sufficing in this respect. Their small tools are as good as the American, their heavy ones as the English; and their textile machinery is rapidly becoming equal to all requirements.

THE SUPERVISION OF CRANES.

During the past month several fatal crane accidents have called attention to the need for more careful inspection and supervision in this direction.

Several men were engaged in hoisting a steel girder weighing nearly one and a half tons at the Savoy Hotel extension works in the Strand, when the crane which they were using fell, and two of them were thrown to the ground, one of them sustaining fatal injuries. At the inquest it was shown that the deceased and three other men were engaged on a staging. The foreman stated that just before the accident he and the other men fastened a chain round the girder which had been raised about twenty feet when the crane "shot over the wall," and the girder fell. It was afterwards found that the centre plate of the crane had shifted. The foreman attributed this to the rain and the stage being wet. The jury added to their verdict of "accidental death" a rider to the effect that the crane was not properly supervised. Another death from a crane accident was caused at the Great Northern Goods Yard at King's Cross. It was shown that in the absence of the craneman the deceased, a contractor, fixed a rope round a log of wood, and then attached the hydraulic crane hook. Whilst the log was suspended by the crane, the hitch-knot in the rope slipped, and deceased was struck on the head. The jury found that death was accidental, but expressed the opinion that no one ought to use the cranes but the cranemen, and that there should be a better method of fixing the ropes. The coroner mentioned that on the previous day he had a similar case in another portion of his district, a man being killed by an iron girder falling upon him.

Five persons lost their lives, and two others were seriously injured at the Falls Foundry, Belfast. This occurred whilst the floor of the apartment beneath the coring-loft was being sunk to the level of the moulding-room floor, and the portion of the coring-loft which crashed down upon the unfortunate workmen filled the space which they had dug.

LOCOMOTIVE ENGINEERING NOTES.

BY

CHARLES ROUS-MARTEN.

Water Troughs and Tender Scoops.

Some forty years ago Mr. John Ramsbottom, Chief Mechanical Engineer of the London and North-Western Railway, devised the system by which locomotives can take in water while running at full speed. It consists, as everybody now knows, of a trough laid in the track along a level length of the "four-foot" way, and a scoop which can be lowered from the tender and up which the water is forced into the tender tank. The advantages of this method are so obvious that it seems amazing to find it still unused on several of the most important British railways, and also on all the French lines, notwithstanding the remarkable progress made by the latter during the last decade. Yet such is the strange fact. For more than thirty years after its introduction on the London and North-Western only a single British railway adopted it, and that was the line deemed at that time the most unprogressive of all, although now standing in the foremost rank—the Lancashire and Yorkshire. Ten years ago—even more recently still—only those two British railways had put down the water-trough and equipped their tenders with the water-scoops. Then the Great Western suddenly awoke to the advantages of the plan when it wanted to run its express from London to Exeter, 194 miles, without any intermediate halt. Subsequently, the Great Eastern desired that its Cromer special expresses should do the 130 miles between London and North Walsham without a stop, and so the troughs were duly laid. Then the Great Northern, North Eastern, and Great Central fell into line, and now the only railways south of the Tweed which have long runs and no water-troughs are the Midland and the London and South-Western; but the Midland is laying them down with all feasible despatch near Oakley, about 53 miles from St. Pancras, and Loughborough, about 110 miles, with a view to making the London-Leeds run of 196 miles without any stop between.

Advantages of the System.

It is surprising to find so enterprising a railway as the Midland still without water-troughs forty years after these were invented and their usefulness proved. The advantages of the system are not confined merely to the facility afforded for making long non-stopping runs when desired. That is undoubtedly a vast convenience, although the desirableness of non-stopping runs of excessive length, save on special occasions, may be open to question. The present writer has long been confessedly a doubter on this head. It has always seemed to him desirable to have a fresh engine with a clean fire and a fresh driver and fireman at fairly frequent intervals. While cordially recognising the splendid work that is done by the Great Western engines on that 194 miles run from London to Exeter, he is unconvinced that the journey from London to Plymouth and Cornwall could not be made quite as quickly, and more advantageously if a stop were made on the Avoiding line by Bristol (118 miles) and the engine changed, the next run being through without stop, for the 95½ miles to Newton Abbott, and the 5 ft. 8 in. "Camel" class engine used for the severe South Devon and Cornish grades taken on then where these grades begin. There may be excellent reasons why this course is not adopted, and it is only instanced as an illustration of the arrangement which is suggested as possibly preferable from a practical viewpoint to the "longest non-stopping run in the world," brilliant as is the latter from the spectacular viewpoint. The same might be said *mutatis mutandis* of the Euston-Carlisle and Euston-Holyhead runs. Of course, it is assumed that the stop would be for locomotive purposes only, else the delay would indisputably be serious, but if the engines were changed at a suitable spot away from the station itself, this could be done in three minutes or less. The change was effected in three minutes more than once at Crewe during the "Race to Aberdeen," and in *two* minutes at Newcastle, where, there being a back-shunt, the relieving engine came on in the rear of the train and hauled it off again directly the operation of coupling was completed.

Lighter Tenders.

But while there may be drawbacks to the utilisation in regular practice of the facilities afforded for making long runs without stop, there can be no

question whatever as to the second advantage conferred by the water-trough and tender-scoop system. The standard tender of the London and North-Western engine that takes a West Coast Anglo-Scottish express to Carlisle weighs 25 tons. The tender of the Caledonian engine which takes on the same train weighs 55 tons. Thus the Caledonian tender has to be 30 tons —more than 50 per cent.—heavier because of the lack of the water-pick-up apparatus. In other words, the locomotive has to haul more than the equivalent of an additional corridor bogie—sheer unprofitable dead weight. Possibly, as the Caledonian also hauls three or four quite unnecessary dining cars weighing from 40 to 41¾ tons each over its heavy road, which includes the 10-mile Beattock bank, mostly at 1 in 75, although the function of those "diners" has been fulfilled before Carlisle is reached, the extra 30 tons in the tender weight may be regarded as a mere "unconsidered trifle." Still, it must count in the load. The Caledonian has certainly a very plausible and perhaps adequate reason for its non-adoption of the trough and scoops—viz., the lack of a sufficient length of level line at a suitable point between Carlisle and Glasgow or Edinburgh. The present writer does not dispute the existence of that difficulty. Nevertheless, he ventures to suggest that at two points, at any rate, viz., near Elvanfoot and Lamington, a slight modification of the permanent way level would enable troughs to be laid and 30 tons saved on every express train load.

The London and South-Western Case.

Another case in which the adoption of the water-trough would be of immense benefit, is that of the London and South-Western with relation to its services between London and the Far West. At present a stop has to be made at Salisbury, because even the large eight-wheeled double-bogie tenders with which Mr. D. Drummond has supplied his express engines will not hold water enough for the run of 171½ miles from Waterloo to Exeter, much of the road being very severe. It has been alleged that the London and South-Western has not a sufficient length of level road in all that distance to enable a single water-trough to be laid down. This is surely an error. The official gradient maps of the London and South-Western show that between Waterloo and Exeter there are no fewer than seven lengths of unbroken level extending continuously for half a mile or more. Thus, near the 52nd mile post from London there is a level stretch of more than a mile in length, and a few miles westward another of half a mile. There are three more, each half to three-quarters of a mile long, between the 90th and 97th mile posts, and two more, each a mile in length, near the 100th and 115th mile posts respectively. So, whatever may be the real reason, manifestly it is not absence of level stretches. Meanwhile, the London and South-Western uses enormous eight-wheel tenders, which add the dead-weight of an extra bogie coach to each train load. This seems a needless discounting of the locomotive power, for it is obvious that if 25 or 30 tons be needlessly added to the load with which an engine has to deal, the efficiency of that engine is *pro tanto* diminished, and in the not uncommon case of an engine being worked up to its utmost capacity—as when the very fine 3½ hour trains between Waterloo and Exeter are loaded to eight bogies or more—then the virtual addition of the equivalent of yet another bogie coach involves one of the two undersirable alternatives—piloting, or loss of time. Manifestly it does not follow that because an engine can run 200 miles without taking in water, that she should necessarily do so, but it does follow that when the water-troughs are used an engine can manage with a tender of much less weight than would be necessary were she not able to pick up water while running, and this means proportionate reduction in the dead-weight, and consequently a practical extension of the engine's capacity.

The Midland Compounds.

The two three-cylinder compound locomotives designed and built by Mr. S. W. Johnson, Locomotive Superintendent of the Midland Railway, have now been at work for about a year, so that some idea may be formed as to the result of the experiment. These two engines, Nos. 2631 and 2632, have been working continuously on one of the heaviest sections of the heavy Midland line—namely, between Leeds and Carlisle. This presents some formidable difficulties to the running of heavy express trains at high booked speeds. A train which leaves Carlisle, only a few feet above the sea level, has to climb some 1,100 ft. before the summit at Aisgill Moor is reached, 48½ miles from the start. The stretch of wild moorland which extends from the Bleamoor Tunnel on the one hand to Aisgill sidings on the other, is approached on either hand by a final continuous ascent, which may be taken for practical purposes as 1 in 100 all the way. Prior to the advent of the compounds it has rarely been found possible to keep time on these sections with expresses exceeding 200 tons in weight behind the tender without the assistance of pilot engines. Possibly an exception may be made in the case of the trains worked by Mr. Johnson's Belpaire type, Nos. 800–804, 810–830, and 2606–2610. But such, at any rate, has been the rule. The two compounds seem to have "changed all that," judging from some recent experiences of the present writer.

Nos. 2631 and 2632 have four-coupled driving-wheels 7 ft. in diameter, leading four-wheel bogie, boiler 11 ft. 7 in. in length, and 4 ft. 8 in. in diameter, firebox 8ft. 6 in. in length, 1,598 square feet of heating surface, of which 150 square feet is given by the firebox, a grate area of 26 square feet, and a working pressure of 195 lb. per square inch. There is only one high-pressure cylinder, which is 19 in. by 26 in., placed inside the framing and under the smoke-box. It drives the leading pair of 7 ft. coupled wheels. There are two low-pressure cylinders each 21 in. by 26 in., which are placed outside the framing, and which also

drive the front pair of wheels. The outside cranks are placed at right angles to one another, the inside crank bisecting the angle between the two. The steam used by the high-pressure cylinder is exhausted directly into the steam chest of the outside cylinders. Mr. Johnson describes the working of his system as follows: "The middle cylinder takes steam directly from the boiler at 195 lb. pressure per square inch, and this steam is exhausted without the intervention of any pipe directly into the steam chest common to the two outside cylinders. Simultaneously with the admission of steam to the high-pressure steam chest, steam at a pre-determined pressure is automatically admitted to the low-pressure steam chest by a specially constructed regulating valve placed on the side of the smoke-box. The regulating valve is so arranged that when the maximum pressure allowed in the low-pressure chests is attained, further supply of steam directly from the boiler is automatically cut off; thus excessive strains are avoided on the moving parts, and although the boiler pressure is 195 lb. per square inch, none of the pistons are ever subjected to a pressure equal to that of the pistons in a simple engine working with a boiler pressure of 170 lb. When working compound, the pressure in the low-pressure chests, according to the position of the reversing gear, varies from 40 lb. to 60 lb.; but for starting or working a heavy train up a steep incline, increased power can be obtained by admitting steam from the boiler through the regulating valve to the low-pressure chests for as long a time as is necessary. The amount of steam that can be passed by the regulating valve between the minimum and maximum limits is governed by a controlling valve placed in the cab. By manipulating this valve the driver can vary the low-pressure steam-chest pressure to suit the work in hand. . . . A piston valve is used for distributing steam to the high-pressure cylinder, and D valves are used for the low-pressure cylinders. Each valve is actuated by means of an ordinary Stephenson link motion, and the reversing gear is so arranged that the high-pressure motion can be moved independently of the low-pressure motion, and one handle will reverse both motions together or separately, as may be necessary. To prevent excessive forward pressure or unnecessary back pressure on the high-pressure pistons, which would occur at starting in some positions of the engine, non-return valves are so arranged that steam can pass from the low-pressure steam chest into either end of the high-pressure cylinder. These valves only open when the pressure on one or other side of the high-pressure piston is lower than the pressure in the low-pressure steam chest." The weight of the engine in working order is 59½ tons, and of the tender loaded 52½ tons.

The Working Results.

Several runs with these fine engines gave some striking results, and afforded convincing demonstration of their efficiency. Within the limits at present available it will only be feasible to refer briefly to the work accomplished in two or three typical cases. Taking a train of 240 tons from Hellifield to Carlisle, one of Mr. Johnson's compounds hauled this load—which would be reckoned as "24 coaches" on the South of England railways—to the Bleamoor summit at the top of the Settle Bank at an almost unbroken rate of 36 to 40 miles an hour. The speed only once dropped to 35 miles an hour, and that was merely for a single quarter-mile, where the grade was as steep as 1 in 92. That speed was the absolute minimum. A smart run followed across the table-land to Aisgill, and then came the long descent of 48½ miles to Carlisle, which was done in 42 min. 9 sec. to the stop, the entire run of 76¾ mile from Hellifield occupying 80 min. 57 sec., which represents an average up and down hill of over 56 miles an hour. The driver eased down considerably during this part of the journey after attaining for a short distance the high maximum of 88·2 miles an hour. In the opposite direction with a slightly less load, about 235 tons, one of the compounds made the run from Carlisle to a signal stop at Keighley, 95¾ miles in 97 min. 39 sec., in spite of "easing down" after Settle, as the train was somewhat before its time. In this case the uphill work was even more remarkable than in the other. Appleby, 30¾ miles from Carlisle, nearly all uphill, was passed in 34 min. 33 sec., the speed never going below 47·4 miles an hour up the steepest grades. Getting on to the still steeper bit after Ormside, most of which is at 1 in 100, and some even as bad as 1 in 85, this speed at first gradually dropped to 45 miles an hour, but then steadily and rapidly recovered to 47, 50, 52, and even 53 miles an hour between Ormside and Kirkby Stephen. Up the final "pull" of 1 in 100 to Aisgill Summit the rate as a rule was persistently maintained at 45 miles an hour. It dropped for ¼-mile to 42·8, then recovered to 45, and then only dropped again to 42·8 on the ¼-mile of 1 in 88 shortly before the Summit. The almost unbroken climb of 48½ miles from Carlisle to Aisgill was done in 57 min. 38 sec., in which time the engine made a climb of some 1,100 ft. During the descent after Bleamoor some exceptional and almost unprecedented speeds were attained. Many of the quarter miles were run in 10 seconds or less, and several in 9·8 seconds each, this representing a speed of 91·8 miles an hour. Such performances may fairly be regarded as conclusive in establishing the high merit of Mr. Johnson's new design.

THE MINING WORLD.

The Miners' Federation.

The annual conference of the Miners' Federation of Great Britain at Glasgow was attended by nearly a hundred delegates, representing some 515,000 miners. The first day's proceedings were confined to the reading of the presidential address, which commenced with a reference to the establishment of the Board of Conciliation in South Wales. Mr. Pickard said that the sliding scale had proved a great failure in many ways. The question was what should be put in the place of the sliding scale. The new scheme with a maximum and minimum wage was one of the greatest events in the history of any trade union. A great deal could be said on this subject, because the Federation itself, before securing a maximum and minimum rate under its scheme, had a great battle to fight. The battle was won, and eventually what was known as a living wage was secured. He proceeded to criticise the proposals of Mr. Chamberlain and Mr. Balfour, remarking that, in his opinion, the only people who would receive any benefit from their adoption would be the employers and the wealthy classes. After references to the Mines (Eight Hours) Bill, the Mines Employment Bill, the Mines Regulation Bill, the Compensation Act, foreign labour, and the new Board of Conciliation, some earnest remarks were made on the subject of ankylostomiasis, which he thought should be considered by a national conference of all the mining districts in the United Kingdom, at which the fiscal question could also be discussed.

On the following day a resolution was carried, urging upon Parliament the necessity of passing the Mines Eight Hours Bill into law. In the course of a discussion on the Mines Employment Bill which followed, there was some difference of opinion as to the age limit of lads proposed. It was finally agreed that in the Bill to be introduced into the House of Commons it should be provided that all lads under the age of eighteen should not work more than eight hours of any twenty-four, and that a register of ages should be kept at the mines of all lads under twenty-one, with the object of ascertaining, for statistical purposes, the numbers of lads injured or killed and at what age.

The next business was the passing of a resolution calling for an amendment in the Weighing of Minerals Bill concerning the clause regulating the work of the check-weigher. It was stated that this Bill would secure that the check-weighman should be entitled when away from his work to use his influence in matters affecting his fellow-workmen, and would also give him the rights of citizenship.

A resolution was also passed on the subject of foreign labour in mines, pressing the Government to issue an order to prevent the employment of unskilled labour, more especially of foreign workmen who do not understand the English language. It was stated that about four thousand or five thousand foreigners were employed in Scotland, whose lack of knowledge of the English language constituted a grave danger to the lives of those working alongside them.

On the third day Dr. Court, Derbyshire, lectured on the subject of ankylostomiasis. He had been extremely astonished to find recently the account of a case that had occurred in a Lanarkshire mine. The man had been a soldier in India, and had been suffering from disease of the spleen, for which reason he had been discharged from the army at the beginning of the year. He returned to his work in the pit, but after a few months he was admitted to the Western Infirmary, Glasgow, suffering from miners' anæmia, and they cured him. That man came from India, and had brought the disease to Scotland. This case illustrated the danger that was caused by men working in mines who were unable to speak English. In his opinion, such men were a positive danger, and ought to be excluded; in fact every foreigner should be excluded unless he could prove that he was absolutely free from disease.

The Takasima Coal Mines.

In 1902 the output of coal of the Mitsu Bishi Company of Takasima and Hasima Islands is shown by the report of the Acting Consul (Mr. J. B. Rentiers) to have been 186,929 tons, valued at £157,464. An article on these mines appeared in the October issue of PAGE'S MAGAZINE, with special illustrations. The report states that the average prices for the year were: for lump, 9 yen 275 sen (18s. 11d.); for mixed lump and small, 8 yen 12 sen (16s. 7d.); and for small coal, 7 yen 31 sen (14s. 11d.), showing a considerable advance on the prices for the previous year, which were respectively 8 yen 41 sen (17s. 2d.), 7 yen 42 sen (15s. 2d.), and 6 yen 99 sen (14s. 3d.), and when the the greater output of 198,579 tons was valued at £154,064.

Owing to the poor quality of coal obtained from the mine on Yokosima, the workings there were abandoned in January, 1902. At about the same time a new shaft was commenced on the opposite side of Takasima to that on which were the existing workings. This will be in full working order by the beginning of next year, and an output of over one thousand tons a day is expected from it; but it is probable that the output from the present workings will decrease. There are five seams of coal, the uppermost is one of 8 ft. thickness, and thence in order downwards come seams of 12, 5, 18 and 3 ft. This last is not being worked. The 18 ft. seam is that chiefly worked, both at Takasima and at Hasima, another island lying about two and a-half miles distant, where it is worked at a depth of 1,500 ft. This is lower than the level of the same seam at Takasima. It is expected that many faults will be found in the seam; but, if the displacement in these be not excessive, it is intended to drive a tunnel through the seam from the one island to the other. Should this be found impracticable, the seam must continue to be worked from either end, or another shaft be sunk from one of several islets near.

It is estimated that the coal at present known to exist immediately around the Islands Takasima and Hasima affords a supply at the present rate of working for at least thirty years.

Undeveloped Mining Possibilities in South Africa.

The presidential address delivered to the Chemical Metallurgical and Mining Society of South Africa, by Mr. S. H. Pearce, reflected some of the questions which are present awaiting solution in South African Mining practice. One of these, which is likely to occupy a good deal of attention, is the matter of whether and how far sorting out waste rock should be carried out. There were many factors in this problem, and he was confident that if individual experiences were given and considered, the payable areas of waste could be located and traced as easily as the more important dykes along the reef line. Mine ventilation in the deeper levels was another subject that was worthy of more notice than had been paid to a question that would yet have to be faced, and in this matter he would suggest that more attention be paid to the purity of air supplied to the air compressors and the

lubrication of the cylinders in view of the accidents that had been caused by the production of foul gases. In a rather striking passage the president emphasised the fact that after all, the gold industry presents only one portion of the future mining operations on the Rand. "If they looked up the metallurgy of gold, they found that in the early days of Australia the first mining was limited to washing up alluvial ground; later it was found payable to hand crush the richer quartz and pick out the nuggets, long before the introduction of stamp mills and amalgamation. So in that country, so long as there was so much apparent profit in it, gold mining would remain the staple industry; but now the country was being thoroughly prospected, and it would not be long before those deposits, which were at present only indicated, would be definitely located, and the production of other metals would become an accomplished fact. Large deposits of iron ore, of a higher class than many being worked in Europe or America, were known, and in some cases in proximity to coal, clay, lime, etc. Copper, zinc, nickel, lead, silver, tin and antimony were known to exist in varying quantities, as also were oil shale areas, while the coal deposits, if not always of a very high quality, appeared to be unlimited and would possibly be supplying the world when all others were exhausted. With regard to chemical industries he remarked that they were indeed backward, though they had at Modderfontein a dynamite factory which he believed was one of the finest of its class, and produced explosives with which it was now difficult to find fault.

The Dynamite Factory at Modderfontein.

An interesting sequel to the above was a visit subsequently paid by the members to the dynamite factory at Modderfontein, which is run by the British South African Explosives Company. The works cover the enormous area of 500 acres, and comprise no fewer than five separate factories and over fifty magazines. They give employment to about three hundred white and eight hundred coloured workpeople. The visitors were shown in turn the mixed acids station, the central acid station, the nitrating house, the separator, the refuse acid tanks, the final washing house, the mixing houses for dynamite No. 2 and blasting gelatine, the kneading house, the cartridge-filling houses, the packing department, the collodion-cotton drying house, the waste acids recovery house, the box factory, the paraffinage, the dope factory, the mechanics' shops, the electric station, the laboratory, and the observatory.

Accidents from Explosives.

At a subsequent luncheon, Mr. S. H. Pearce, the President of this Society, gave the toast of Mr. Wm. Cullen, General Works Manager, and the staff of the factory. Mr. Cullen, in the course of his reply, said that they were turning out at the present time more nitro-glycerine than any other factory in the world, even with the present limited production on the Rand. Not only had they to carry tremendous stocks of explosives—they had now in hand about 60,000 cases—but they had to carry immense stocks of raw material, because they had not yet found the material in that country in sufficient quantity.

He had been comparing the relative ratio of fatalities in a large factory like that, where the potential risk was always present, as compared with that on the mines, where the potential risk was not so much present; and he had been led to the conclusion that the amount of accidents, very often fatal, was out of proportion altogether to the use of the explosive, and he went so far as to say that every employee there would rather be connected with the manufacture of explosives than with the use of them. He was fully convinced that there was some educational authority needed along the line of reef to point out to men, in a common-sense manner, the precautions which they ought to take, and which they should be made to take, by legislation. He thought there was great room for improvement, and personally he was quite willing, under a technical education scheme, to do all he could by lecture and demonstration to assist in reducing the frightful mortality. Reading the paper from day to day, and seeing so many accidents, they had still no conception, unless they studied the official returns from year to year, what the cumulative effect really was, and to his mind it was something frightful. Of course, even under the best and strictest legislation, accidents would happen; but he put the present mortality on the reef down to this, that every miner thought he was an expert in the use of explosives. No doubt some of them were, but at least 50 per cent. were not. He was sure his staff would be willing to help, and he hoped the Society might inaugurate such a scheme as he had suggested.

The Training of Mining Engineers.

In the course of an admirable presidential address to the members of the North Staffordshire Institute of Mining and Mechanical Engineers, Mr. A. M. Henshaw emphasised the individual responsibility of those charged with the control of the great industries of this country with regard to the efficient training and education of the leaders of industry, and more particularly those engaged in mining. In the industrial struggle for supremacy a higher standard of education, technical, scientific and commercial, would be their best weapon and most invulnerable armour. He believed they had realised their position in the matter, that they were making progress, and that the result would be seen in years to come. In the course of a few practical remarks on the education of mining students, he observed that this should begin at an early age. The student's profession should be decided upon as soon as his natural inclination asserted itself, and at the higher grade school his future career would be greatly assisted by a good groundwork in practical mathematics, physical science and chemistry, which should be made interesting by laboratory practice, supplemented by the use of simple tools and the teaching of craftmanship. If after such preparation at, say, the age of sixteen he was found to possess a mechanical turn of mind, had plenty of common-sense, faculty for plodding, fondness for study, a sturdy constitution, and the instincts of an honest man and a gentleman, they had the material necessary for the making of a successful man who would uphold the best traditions of his profession. In no profession was early practical knowledge more necessary than in mining, and whilst each was essential, principles and practice must go together, so that work and study should run concurrently. If college training were decided upon he would first give the student twelve months' practical work at a colliery, whilst he was young enough to delight in the new experience of life underground, feeling no false shame in his ignorance, or afraid to ask questions from anyone. His college course following should extend to at least three years, but to be thoroughly efficient there should be breaks or intervals spent at a colliery or works with frequent visits to works during the college term for the purpose of studying the practical side of the subject he was working upon. He insisted strongly on the importance of practical work for the mining student, who would never become a great leader without it.

SHIPBUILDING NEWS.

Turbines for Ocean Liners.

[illegible] bility to ocean service for their new Atlantic liners. The Parsons and Rateau turbines are being fully examined, and the Curtis turbine can hardly be ignored— [illegible] bine which is coupled to an electrical generator of 5,000 kilowatt capacity is practical proof that electrical engineers are satisfied of its efficiency. In the Curtis turbine the shaft is vertical, and the whole weight of the revolving part is borne by an oil film delivered by a pressure pump to a lower bearing. The delivery of steam to the turbine is controlled by a system of electrically operated individual valves worked on a small controller, a centrifugal governor moving a controller. This turbine and electric generator stands 25 ft. high, and is 14 ft. in diameter. The total weight of the turbine and generator is about 400,000 lb. It does not follow, however, that a system of proved success for land service will be found effective for marine service.

[illegible] the turbine in the Canadian service. Lord Strathcona, on his return from Canada, stated that the proposed fast steamship service between Canada and Britain had not been dropped. The question was then under consideration by the Canadian Government, and he looked forward to the proposal being carried out at no distant date. They had to recognise, he said, not only the possibility, but the practicability of the turbine for trans-Atlantic steamers. There was no doubt that it had made rapid strides, and the question of a fast steamship service to Canada could not be settled without taking the turbine into consideration. [illegible] Clark and Co., Ltd., Belfast, an order for a new turbine steamer for their Liverpool to Canada mail and cargo service. This vessel, which is to be ready in the course [illegible] have a speed of 17 knots. She will thus be one-fifth larger than the *Tunisian* or *Bavarian*, which are the firm's present largest vessels, and about two knots faster. She is to be fitted with Parsons' turbines instead of [illegible] have been considering the question of turbines for some years, and have now decided to take the important [illegible]

The United States Navy authorities have also appointed a Commission to examine carefully all available data with regard to the working of turbines, to inspect vessels in which they have been installed, and to prepare an estimate to be submitted to Congress in [illegible] turbines. It is expected that this Commission will arrange for the fitting of turbines to a torpedo boat for careful tests. The only turbine-driven boats in United States waters are yachts— [illegible] make; a second, the *Emerald*, built for Sir Christopher Furness by Messrs. Alexander, Stephen and Son, of Glasgow, and subsequently bought by Mr. George Gould; and the third, the *Tarantula*, constructed by Messrs. Yarrow for the late Colonel M'Calmont, and now owned by Mr. Vanderbilt.

New Amalgamation.

The fourth quarter of the year has opened with some improvement in the shipbuilding world, as quite a fair (though not large) amount of new orders have been booked. It is also marked by a new amalgamation. The directors of Messrs. Charles Cammell and Co., Cyclops Works, Sheffield, have made arrangements for amalgamation with Messrs. Laird Brothers, Ltd., shipbuilders, Birkenhead; and a meeting of shareholders was held in October to confirm the terms of purchase conditionally agreed upon. The purchase will date as from the 1st June last, and the purchase price is to be paid partly in Ordinary shares, partly in Preference shares, and partly in cash. This will involve an increase in the capital of Charles Cammell and Co., and it is proposed to offer existing holders of Ordinary shares in that company new shares in the proportion of two Ordinary shares for every complete set of five shares now held by them at a premium of £3 per share. It is also arranged that the name of the company shall be altered so as to include the name of Laird, and two of the directors of Laird Brothers join the board of the Cammell Company. This will make another conjoined producing-capacity for warships and armour plates.

New Line Between Canada and France.

[illegible] and passenger steamers between Canada and France, to be operated by the Compagnie Trans-Atlantique France-Canada. By the terms of the contract Mm. Colombier Bros., of Bordeaux, agree to establish the line with a minimum of eighteen voyages per year. The summer ports in Canada will be Montreal and Quebec, and the winter ports Halifax and St. John. There will be twenty-four voyages each way per year. [illegible] but may be increased to fifteen years. The company has ordered four steel steamers, and the proposal is to have ten-day sailings. There will be accom- [illegible] line is to develop trade between Canada and France in grain, lumber and cattle, and to promote immigration.

[illegible]

Vessels Lost and Condemned.

Following up the statistics we have recently given [illegible] figures about vessels totally lost, condemned, etc., published by Lloyd's. During 1902 the gross reduction in the effective mercantile marine of the world amounted to 872 vessels of 700,690 tons, excluding all vessels of less than 100 tons. Of this total, 301 vessels of 408,363 tons were steamers, and 571 of 292,327 tons were sailing vessels. The return exceeds the average [illegible] tons; as regards sailing vessels it is below the average by 204 vessels and 67,716 tons. Apart from vessels broken up, condemned, etc., the United Kingdom steam tonnage lost during 1902 is below the average of the preceding eleven years by about 48,000 tons, while the tonnage owned has increased during that [illegible] Strandings and casualties comprised under the term "wrecked" are the most prolific cause of reduction. To such casualties are attributable 40 per cent. of the losses of steamers, and 42 per cent. of the losses of sailing vessels. The next cause is by condemnation, breaking up, etc., about 22 per cent. of the vessels removed from the merchant fleets of the world being accounted for in this manner. Of other causes of loss, collision is the most general for steamers (13 per cent.); while for sailing vessels, cases of abandonment at sea come next (11·7 per cent.). Cases of abandoned, foundered, and missing vessels comprehend 16·9 per cent. of the steamers, and 25 per cent. of the sailing vessels removed from the mercantile marine during 1902. A comparison can be made between the percentages of loss suffered by each of the principal merchant navies in the world. That of the United Kingdom forms a very moderate percentage of the mercantile marine of the country, and compares favourably with the losses sustained by other countries The merchant navies which exceed a total of 1,000,000 tons are those of the United Kingdom, the British Colonies, the United States, France, Germany, Italy and Norway Of these countries the United Kingdom shows the smallest percentage of loss, viz., 1·46 of the vessels owned; Germany follows with 2·25 per cent.; and Norway with 4·58 per cent. As regards steamers, while the percentage for the United Kingdom stands at 1·11 the average of the percentages of loss for the other six countries is 1·48. For sailing vessels, the percentage of loss for the United Kingdom is 2·97, and 4·64 for the other [illegible] The losses of steamers belonging to the chief maritime [illegible] and 1·14 per cent. of the tonnage owned, while the losses of sailing vessels reach 4·18 per cent. of the number and 3·98 per cent. of the tonnage.

Changes under the Morgan Combine.

The long-continued rumours of impending changes in the composite companies of the Morgan Shipping Combine seem to resolve themselves into this, that the managers of the White Star Line have taken over the whole Dominion Line service, thus extending the sphere of the White Star flag. The service between Boston and the Mediterranean during the winter will be by the new s.s. *Columbus*, together with the *Commonwealth* and *New England*. These vessels, on transfer to the White Star Line, are re-named *Republic*, *Canopic*, and *Romanic*, respectively. The *Columbus* (or *Republic*) is a twin-screw steamer of 15,378 tons gross register, with engines capable of maintaining a speed of 15½ knots, and with passenger accommodation for 280 first class, 250 second class, besides a large number of third, class, The *Canopic* and *Romanic* are on similar lines, of slightly less tonnage, with the same speed, and arranged to accommodate nearly the same number of passengers. The *Romanic* will leave Liverpool for Boston on November 19th, and on December 3rd will sail from Boston for Gibraltar, Naples, and Genoa. The *Republic* will sail from Liverpool for Boston on December 17th, and on January 2nd leaves Boston for Mediterranean ports. The *Canopic* will sail from Liverpool on January 21st, and from Boston on January 30th. Afterwards, these steamers will keep up a fortnightly service between Boston and the Mediterranean during the season. The Liverpool and Boston service will be maintained during the winter by the *Cymric*, hitherto engaged in the White Star Liverpool and New York Friday service, and the *Mayflower*, which has been renamed the *Cretic*. The *Cymric* and the *Cretic* are both twin-screw steamers of over 13,000 tons gross register, with a speed of about 15 knots per hour. The *Cretic* will leave Liverpool on November 26th, returning from Boston on December 10th, and the *Cymric* will sail outwards on December 10th, returning on December 24th, thereafter fortnightly until May 5th, when the weekly service between Liverpool and Boston will commence.

IRON AND STEEL NOTES.

Dumping Grounds for America.

The United States Steel Corporation is reported to have closed down a number of plants and to have discharged some thousands of workmen, owing to marked shrinkage in the home demand for steel. The profits for the quarter ending September 30th show a material decline, and the directors have decided to reduce the dividend on the common stock by one-half. The net earnings were 32,303,000 dols.—a decrease of 4,642,000 dols. as compared with the corresponding period of last year. The home demand having slackened in such a marked degree, we hear that the Corporation is taking active steps for promoting its business with foreign countries. The large locomotive and car builders have been studying the subject for some time with a view to undertaking vigorous work when the state of the home market would enable them to make reasonable deliveries in point of time. The tremendous tide of home business experienced in the past, has kept in suspense some carefully matured plans in this direction, but now we gather that "dumping" is to commence in good earnest, and we may expect the offer of prodigious bargains in rails, steel bars, constructional iron and steel, sheets and wire, etc. The World's Fair at St. Louis next year will be participated in by most of the countries which are possible purchasers in this line, and the foreign attendance will probably be beyond all precedent. It is, therefore, considered likely to afford an excellent opportunity for the advancement of American iron and steel.

German Precautions.

German producers appear to have been terribly afraid of similar dumping intentions as regards the Fatherland, though they were assured some time ago by Mr. C. M. Schwab that the coming American campaign would be conducted in Great Britain, China, Japan, South Africa, and other countries having no Protective tariffs.

The two German experts, Messrs. Loez and Boeker, who went to America at the instance of the Association of German Iron and Steel Producers, were agreed in the general statement that the so-called American danger has been exaggerated. Nevertheless, Mr. Boeker entertains the view that Germany requires a Protective duty of a lasting character in order to be immune against it. At the present time the Germans are endeavouring to put their trade on a uniform basis, and it is probable that in a few months the German steel trade will be under the control of a single combination. It is stated that twenty-nine of the principal works in Rhenish-Westphalia, the Saar district, Central Germany, and Upper Silesia have already signified their assent to the draft of the rules for controlling the industry, both as regards the home and export trade of the country. It is intended to include in the new trust the present members of the existing syndicates in semi-finished steel, girders, rails, and plates and sheets, and to give to the combination the form of a limited company, as in the case of the Westphalian Coal Syndicate, in order to constitute it on a more solid foundation than would otherwise be possible.

The Fiscal Cul de Sac.

The position in the iron trade throws us back upon the fiscal controversy, which is at present occupying so many minds throughout the country. Mr. A. Lamberton was driven into the same *cul de sac* the other day when reviewing the history of the iron and steel, and coal trades before the West of Scotland Iron and Steel Institute, of which he is President. Having arrived at the conclusion that instead of being first in the iron and steel industries, this country was at present a bad third, viewed from the standpoint of output, he said "the indications were pretty clear that during the next few years our imports of iron and steel would greatly exceed anything they had yet reached. The enormous Protective tariffs of the United States and Germany made it certain that in times of trade depression in these competitive countries their surplus material would be offered to us at prices which our own manufacturers could not compete with. What was to be done? Were we fairly and squarely beaten, or had our competitors an undue advantage over us?

"The ruling spirit of the British race was that wherever there was a fight there should be fair play. If, therefore, our iron and steel makers had to compete with the foreigner for this country's requirements and the foreigner was allowed to offer his goods in competition with ours at less money than it cost him to produce and deliver, was that a fair fight? The spirit of the British race always claimed the privilege of a fair field and no favour, and when there existed, as there undoubtedly now existed, a widespread feeling that important changes had come over the conditions as compared with the time when our present fiscal laws were enacted, he thought it was only reasonable that in such a vital question the greatest forbearance should be shown by people holding adverse views.

"By all means let this great Imperial question be freely and exhaustively studied and discussed, and when that had been done the country would be able to come to a decision upon a problem which he ventured to say few of them to-day could pretend to understand. Was it certain, was it, indeed, probable that the fiscal laws which we made fifty years ago were incapable of improvement to-day? Had we reached finality alone on this single question, whilst in all other directions we had been undergoing radical changes? Surely this was fair matter for argument, and he therefore pleaded that all classes in this country ought to be prepared to grant the fullest discussion of this subject, so that the facts might be accurately ascertained and a settlement arrived at that would be for the lasting good of the nation and of the Empire." At the present time Mr. Lamberton cannot claim that there is any lack of discussion.

French Iron and Steel.

The following table, based on statistics from the French *Journal Officiel*, shows the production of iron and steel in France during the first six months of 1903, as compared with the corresponding period of the previous year. The figures are provisional only:—

	First six months.	
	1902.	1903.
Cast iron—	*Tons.*	*Tons.*
Forge pig	958,243	1,095,120
Foundry pig	200,505	270,301
Total	1,158,748	1,365,421
Iron—		
Rails	128	7
Wrought iron (various) ..	289,147	295,547
Sheets	27,323	23,191
Total	316,598	318,745

	First six months.	
	[illegible]	[illegible]
Steel—	*Tons.*	*Tons.*
Rails	[illegible]	[illegible]
Wrought steel (various) .	[illegible]	[illegible]
Sheets	138,603	[illegible]
Total .. .	617,835	666,571
Bessemer and Siemens - Martin ingots	[illegible]	942,658

Wages in South Wales.

The South Wales and Monmouthshire Iron and Steel Workers' Sliding Scale Joint Committee have, on the auditors' award of prices for the three months ended August 31st, decided that wages be reduced 2½ per cent. in the current quarter.

Midland Iron and Steel.

At a meeting of the Midland Iron and Steel Wages Board held at Birmingham, Sir Benjamin Hingley presiding, Messrs. Benjamin Smith, Son, and Wilkie, accountants, reported that they had examined the books of the eleven firms on whose returns wages are regulated under the sliding scale. The average net selling price of iron reported to the Midland Iron and Steel Wages Board for July and August was £6 15s. 10·87d. per ton on a total output of 27,177 tons. In the preceding two months the average price was £6 17s. 1·82d. and the total output 28,686 tons. The following were the details relating to the different classes of iron on which the ascertainment is based: Bars, total tonnage, 18,576, average net price £6 14s. 3·13d.; angles and tees, tonnage 851, price £6 19s. 8·89d.; plates and sheets, tonnage 2,432, price £7 14s. 0·84d.; hoops, strip, and miscellaneous, tonnage 5,316, price £6 12s. 8·73d. In the corresponding period of 1902 the total output of twelve firms whose books were examined was 27,673 tons, and the net average selling price was £6 18s. 4·01d. per ton. Twelve months ago puddlers' wages were advanced from 8s. 6d. to 8s. 9d., and the wages of other tonnage men were increased by 2½ per cent. These rates have been maintained since that time, and by resolution of the board provided for their continuance for the ensuing two months.

Nickel Steel.

Several important railway companies in the United States are now experimenting with nickel steel rails. Among these the New York Central and Hudson River Railroad has obtained from the Carnegie Steel Company 204 tons of nickel steel rails, with the idea of laying them for experimental purposes on the West Albany Hill, where there is a steep grade and heavy traffic. These rails were rolled during June under the inspection of Dr. P. H. Dudley, and are now being laid. The chemical composition of the rails was found to be as follows:—

Carbon	·418	per cent.
Silicon	[illegible]	,,
Manganese	·79	,,
Nickel	3·35	,,
Phosphorus	·094	,,

Nickel steel is to be used for most of the tension members and pins of the great cantilever bridge now being constructed at Blackwell's Island, New York City. This bridge will have one span of 1,182 ft., another of 984 ft., and a third of 630 ft., in addition to two side spans of 469½ ft. and 459 ft. each respectively. The nickel steel used is to contain 3½ per cent. of nickel.

Loss of Iron in Blast Furnaces.

In smelting iron ore in the blast furnace, according to Mr. B. Osann, in *Stahl and Eisen*, metal is lost in the form of ore carried off as dust in the gases and by the scorification of ferrous oxide in the slag. The actual loss is apparently diminished by the iron content in the coke ash and the limestone flux which is not taken into account in making up the charges. The total loss of metal ranges from nothing up to 5 per cent. and even more, in the most unfavourable cases. In smelting unroasted oolitic ores the average is probably about 3 per cent. Calcined spathic iron ore and burned pyrites residues give rise to much dust in the gases. The quantity of dust carried per cubic meter of gas discharged varies between 5 and 20 grams, the proportion of iron contained varying between 12 and 45 per cent. With a consumption of 110 parts of coke per 100 parts of metal smelted, the coke containing 7 per cent. of ash assaying 7 to 11 per cent. ferrous oxide, which percentage of iron is to be found in the ash of Westphalian coke, the loss of iron in the form of dust carried off by the gases is completely compensated by that which is introduced in the coke.

High-speed Steel in Shaped Cutters.

In the course of an address before the American Society for the Advancement of Science, Mr. E. L. French stated that, whereas until recently the extensive use of self-hardening steel has been confined to extremely simple forms of tools, where all the work necessary to fit them for service could be done by forging and grinding to shape, now, however, there have been perfected processes of annealing which admit of self-hardening steel being as readily machined as most of the ordinary carbon grades. The high-speed qualities of the steel, as found in lathe and planer tools, can thus be utilised for cutters of all kinds, complicated or simple in pattern, as a great saving of time through the increased amount of work such tools are capable of turning out. The greatest advantage, however, which such steel possesses over the ordinary water hardening varieties lies in the fact that there is absolutely no danger of loss in the hardening bath, where so many costly tools meet their end, for it is only necessary to heat such a steel to redness and lay it aside to cool, when it will have regained the hardness it possessed before annealing.

Canadian Iron and Steel.

While 86,090 tons of pig iron represented Canada's total make in 1900, when interest was first awakened in the industry, the production in 1901 was 244,976 tons, and in 1902 it was 319,557 tons. Stocks last year decreased from 59,472 to 20,000 tons. New furnaces of from 200 to 250 tons capacity per day are being finished, which will make an increased output of over 4,000 tons per week. The output of steel of all kinds in the nineties varied between 26,000 and 16,000 tons, and has now reached to 182,037 tons. This is due to the development of the Dominion and Algoma Companies' works. Two 18-ton basic open-hearth furnaces of the Cramp Company will further increase the total this year. There were rolled 33,950 tons of steel rails last year, as compared with 891 tons in the previous year. A plant for making wrought iron pipes is being erected in Ontario, to have a capacity of 17,000 tons of finished rolled material and 15,000 tons of wrought iron pipes.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

The Financial Results of Power Companies.

Although power transmission plants are being put down in nearly every country in the world many are still sceptical as to whether they will pay their way. In some cases, as in California, where there is no coal or other fuel available, the *only way* to get power is by long transmissions; and in such case the question of paying is of secondary importance.

In Northern Italy two power transmission companies have been at work for some time, and have been most successful. One is the Société Generale Italiana Edison di Electtriceta; its shares were issued at 150 and they are now at 592, the last year's dividend being twenty-two lire. The other company is the Société Lombarda per la Distribuzione dell'Energia Electrica; its shares were issued at 500 and the present market price is 930, the dividend being thirty-five lire or seven per cent. on the par value.

The average cost to these companies, of a kilowatt year is about £5 and the average price charged is about £10, but, of course, a good deal depends on the amount of electric energy taken by the various consumers, and also the way they take it.

The Board of Trade and High Tension Wires.

The present Board of Trade printed regulations regarding the pressure on overhead lines carrying alternating current are that the pressure must not exceed 250 volts and the energy transmitted through any one wire is not to exceed 50 kilowatts. On paper this looks pretty bad for the future of electrical transmission of power business, it is therefore all the more interesting to discover that like the proverbial Act of Parliament these regulations can apparently be driven through by a coach and four. For example, a certain zinc mine near Aberystwyth, in Wales, which had been closed for some time, was re-started some four years ago and fitted with a 300-h.p. three-phase plant, the whole of the distribution being by bare wires. Although in many respects the installation is contrary to the Board of Trade Regulations, yet they apparently had no power and further *showed no desire to interfere*. Engineers, in fact, are now finding out that the printed regulations are one thing and the ideas of the Board of Trade officials are another. Various power transmission companies are now about to install bare overhead wires at 6,000 volts, which pressure is about the limit to which it is either necessary or desirable to go in this country of short distances and a moist atmosphere.

On the Continent 15,000 and 20,000 volts is fairly common, whilst in America the pressures have gone up to 50,000 volts, yet we do not hear of any accident or of opposition. The people in other countries appear to have satisfied themselves that it is to the public good that the natural sources of power should be developed. The high tension lines are as far as possible carried over private ground, the poles themselves being made unclimable. We shall have to learn to get used to these overhead lines, and also put up with poles of wood instead of steel, as the latter are not safe for high tension work.

Worm Gearing for Motor Drives.

Worm gearing differs from most other forms, belting, spur gearing, etc., in that it requires very accurate design and manufacture. It has always been more or less under a cloud on account of bad examples of the gear which have been set to work. Several firms, however, amongst whom may be mentioned Messrs. Ernest Scott and Mountain and The Oerlikon Company have consistently stood by the gear, and by turning out good work have helped materially to win for it the position it now holds as one of the best mediums for electric motor driving. One of the distinct advantages of the gear is its *noiselessness*, and this undoubtedly has a money value. As there still exists a certain amount of mistrust as to the efficiency, it may be of interest to give some figures obtained by the Oerlikon Company.

The efficiency increases with the angle of inclination up to a certain point, and with the smallness of the coefficient of friction and knowing these two factors it is possible to calculate the theoretical efficiency as shown in the table.

Experience shows that for larger angles of inclination than 25° to 30° the efficiency increases very little, especially if the coefficient of friction is small, and this fact is of importance in practice, because, for reasons of gear ratio and conditions of a constructive nature an angle greater than 30° cannot be employed. The coefficient of friction increases with the load and diminishes to a certain extent with increase of speed. Besides the friction between the worm and the wheel teeth there is also the friction of the spindle bearings and the ball bearings for taking the axial thrust. To obtain the best results, there must be very careful choice of dimensions of teeth, of the stress between them, and the angle of inclination. Also the most accurate workmanship in which the hardening of the worms without any consequent *retouching*, forms an important part.

Test of a Worm Gear.

To show what can be done, the following are the results of a test with an Oerlikon worm gear for a colliery winding engine :—

The motor gave 30 b.h.p. to 40 b.h.p. at 780 revolutions. The normal load—25 b.h.p., but at starting it can develop 40 b.h.p.

TABLE GIVING THEORETICAL EFFICIENCY OF WORM GEARING.

Coefficient of friction	Angle of Inclination								
	5 deg.	10 deg.	15 deg.	20 deg.	25 deg.	30 deg.	35 deg.	40 deg.	45 deg.
0·01	89·7	94·5	96·1	97·0	97·4	97·7	97·9	98·0	98·0
0·02	81·3	89·5	92·6	94·1	95·0	95·5	95·9	96·0	96·1
0·03	74·3	85·0	89·2	91·4	92·7	93·4	93·9	94·1	94·2
0·04	68·4	80·9	86·1	88·8	90·4	91·4	92·0	92·2	92·3
0·05	63·4	77·2	83·1	86·3	88·2	89·4	90·1	90·4	90·5
0·06	59·0	73·8	80·4	84·0	86·1	87·5	88·2	88·6	88·7
0·07	55·2	70·7	77·8	81·7	84·1	85·6	86·4	86·9	86·9
0·08	51·9	67·8	75·4	79·6	82·2	83·8	84·7	85·2	85·2
0·09	48·9	65·2	73·1	77·6	80·3	82·0	83·0	83·5	83·5
0.10	46·3	62·7	70·9	75·6	78·5	80·3	81·4	81·9	81·8

Worm gear ratio 13·6 to 1, the helicoidal bronze wheel having 68 teeth on a pitch circle of 185 millimetres and the worm 5 threads.

The power required at no load for the whole of the gear was 520 watts, corresponding to 2·8 per cent. of the normal. The efficiency at one-third normal load gave 90 per cent., at full load 94½, and at 50 per cent. overload 93 per cent.

The efficiency of the *worm and wheel alone* is higher, and knowing the no load power, it calculates out at 97½ per cent. According to the above table of theoretical efficiencies this gives the coefficient of friction as 0·01. To obtain a reduction of 13·6 to 1 with spur gear would have necessitated two pinions and two wheels with their spindles and bearings, and if the bearing friction was taken into consideration the efficiency of such gearing would certainly not have reached the above-mentioned figure of 94½ per cent. at full load.

Study in Leisure Time.

The approaching winter months should turn the young engineer's thoughts to the question as to what he will do with his leisure during the long evenings. If he is a wise young man he will make arrangements to attend courses of lectures at one of the many secondary educational schools or colleges, or if he is situated in a town or place where there is no suitable educational establishment he should enter his name with one of the many correspondence schools.

No engineer worth the name can afford to stop studying when he leaves school or college; in fact, the most successful men in the profession are the hardest students. There is no such thing in engineering, and especially in electrical work, as *marking time*; a man must move forward nowadays, and study is the best protection against mental rust and retrogression.

There is another point of view which the young electrical engineer must bear in mind, and that is, he may unfortunately, and through no fault of his own, find himself out of employment. For example, financial difficulties may cause a cutting down of the staff and workmen, or possibly a stoppage altogether, or he may be helping to work out some new process, possibly a new accumulator or other electro-chemical idea, and it is found that although technically a success there is not sufficient money in it to justify further development. Again, a common cause of being out of employment is a change of manager. Some men like to bring their own assistants along with them, and may be somewhat jealous of assistants of a former manager. In such cases the enforced leisure is well spent in study, preferably some subject in which the engineer has not previously had experience. Many an engineer whose professional career has been most successful can look back to unemployed periods which he was wise enough to take advantage of, for needed study.

In some quarters it is fashionable to sneer at evening classes and correspondence courses, and that is one reason why the above note has been written. Twenty years' experience has taught the writer that it is never too late to learn, and the best lessons are often picked up at the most unlikely times.

Works Lecturers for Apprentices.

For some time it has been the practice of up-to-date works to appoint some member of their staff to specially look after the apprentices, and give lectures, etc. It is an excellent idea, given the right man—but such a man generally requires a fair salary. One firm the writer knows of engaged an engineering lecturer from a neighbouring polytechnic to deliver lectures in theory during workshop hours, and it answered fairly well, although the lecturer was at a disadvantage in not being able to go about the works with the students. Some employers ask themselves whether it is worth while going to this expense, seeing that directly he is trained the apprentice may take his knowledge elsewhere. They have, however, the remedy for this in their own hands by adopting the practice in vogue on the Tyne, where a boy must agree to *remain a certain number of years* after his apprenticeship term is ended. The writer happens to know that this system works excellently, and nowhere else in England are there better all-round engineers than can be found on the North-East coast.

A new and to some extent a startling departure has been made by the Vickers, Sons, and Maxim Company, at Erith, in appointing a monk of the Franciscan Order to teach their apprentices applied mechanics, and generally look after their scientific studies. The monk has excellent credentials for the efficient performance of his duties, and is said to be equally at home in the classroom and the laboratory. It is interesting to note that it would have been impossible for such a selection to have been made by a publicly elected body of men, especially in such a Nonconformist centre as West Kent. The Directors of the company, however, being removed from any pressure of this kind, have been able to select a man whose recommendations are that he knows what he has to do, and is able to do it.

POWER STATION NOTES.

Steam Turbine Development

One of the most important developments in power station work is the rapidly increasing employment of steam turbines. The extent to which this movement is going on is surprising, for besides the original makers, Messrs. Parsons and the De Laval Companies, there are now Brown Boveri and Co., the Westinghouse Co.'s at Pittsburg and Manchester, the Brush Electrical Engineering Co., Greenwood and Batley, of Leeds, the General Electric Co., and British Thomson-Houston Co. at Schenectady and Rugby, all hard at work. The Rateau Turbine is also being made in Germany.

The Curtis turbine made at Schenectady and Rugby has a vertical spindle and thus takes up very little room. For example, a 5,000 kilowatt set made for the Chicago Edison Electric Light Company runs at 500 revolutions per minute and has the following dimensions: Overall height above concrete foundations, 25 ft. 6 in.; overall width, including exhaust flange, 17 ft. 6 in.; width at right angles to above and including the steam inlet valve, 19 ft. 6 in. As a matter of fact these are extreme figures, the main body of the machine, that is to say the alternator, is circular and only 12½ ft. in diameter.

The great saving is space, which these figures represent, can be gathered by comparing with the recenty-installed 5,000 kilowatt slow-speed engine sets in the Manhattan Power Station, New York. These engines run at 75 revolutions a minute and are a combined vertical and horizontal type. They are over twice the height and take up no less than *nine times as much floor space* as the Curtis turbine. It will thus be seen that the saving in foundations alone is a very important idea, especially when we consider that the respective weights are as eight to one. It may be mentioned that if the turbine had a horizontal spindle in place of the vertical one, the floor space would be two to three times greater, but even then it would, of course, be very considerably less than the slow-running engine set. There is no doubt the vertical spindle turbine has come to stay, and the wonder is that it was not so constructed years ago.

Types of Steam Turbines.

In a steam engine the expansive force of steam is taken up by the application of pressure against moving pistons, whereas in a steam turbine the expansive force imparts motion to the steam itself, and this motion is absorbed by the steam impacting against a series of blades mounted on a revolving spindle.

In the Parsons' turbine the steam is carried in an axial direction through many alternate stationary and rotating rows of blades or vanes. Expanding as it goes along it acquires velocity which is partly asborbed by the revolving blades.

In the De Laval turbine there is only one wheel or row of vanes, and the velocity of the steam is raised to a very high value by an ingenious *expanding nozzle*, so designed as to convert nearly all the expansive force into velocity in the steam itself.

To show what this velocity is, it may be well to give a few figures bearing on the point. If steam at 150 lb. pressure per square inch is allowed to expand down to atmospheric pressure the speed it will impart to itself will be close on 3,000 ft. per second, whilst if it is expanded into a vacuum equivalent to 28 in. of mercury, the velocity will rise to over 4,000 ft. This is an extremely high figure, in fact, it is impossible to build a wheel which will run at such a speed, the nearest approach to it being the De Laval, with 1,200 ft. per second. Even then it is necessary to have a reduction gear of ten to one to bring the revolutions down to practical limits for dynamo driving.

Modern turbines, such as those being made by the Westinghouse and Thomson-Houston Companies, aim at combining the best points of Parsons and De Laval. In the Curtis turbine, for example, the steam is partly expanded through De Laval nozzles and the velocity abstracted by successive impacts with several rows of blades somewhat similar to the Parsons', the steam is then passed through another set of expanding nozzles and another set of rows of blades and so on through a series of stages, varying according to the degree of expansion, and the practical limit for peripheral speed—the lower the peripheral speed the more numerous the stages.

The governing of the Curtis turbine is very simply effected by successive closing of nozzles and consequent narrowing of the active steam belt.

The Parsons' Turbine on the Continent.

When the firm of Messrs. Brown, Boveri and Co., Baden, decided to manufacture the Parsons' steam turbine, it was a foregone conclusion that they would turn out something with characteristic and shapely lines. It was to be expected also that as the Continent had not gone through the high-speed engine stage, buyers would be all the more impressed with the great saving in space given by the steam turbine over a slow-running engine set. The avidity with which it has been taken up has, however, been somewhat of a surprise.

The following table shows some relative outputs of the respective firms, and it will be seen that from 1900 to June 1st, this year, the Swiss firm has built no less than 77,530 h.p. :—

	Years.	Number of Turbines.	Total Turbine output.	Size of largest Turbine.
			h.p.	h.p.
Parsons and Co.	1884 to 1890	360	5,000	20
	1890 to 1895	240	40,000	600
	1896 to 1902	234	230,000	5,000
Brown, Boveri and Co.	1900 to 1902	31-37	28,810	5,000
	Jan. 1 to Mar. 20	11-14	12,630	2,250
	Mar. 20 to June 1, 1903	17-19	36,090	8,000

Amongst the largest turbines they have built, or have in hand, are :—

Two of 2,250 h.p. (three-phase) for the Electrict Light Company, of Turin; one 5,000 h.p. (single-phase) for the Frankfurt Municipal Electricity Works; one of the same size (three-phase) for the Edison Company, Mailand, and another for the Electricity Works, Essen; a 10,000 h.p. turbine is in hand for a German cruiser and another of 5,000 h.p. for a torpedo-boat, these latter being constructed at Messrs. Brown, Boveri and Co.'s Mannheim works.

Relative Weights, etc.

Some figures as to the relative weights, etc., of steam turbo-dynamo machines and slow-running engines sets may be of interest. At Frankfort the weight of the turbine was 9,000 kgs. and the alternator

11,000 kgs., making a total of [illegible] kgs. Whereas a slow-running set of same output was, engine 46,000 kgs., alternator 96,000 kgs., a total of 142,000 kgs., or over seven times the weight. In another case the relative total weights were 400,000 and 66,000 kgs., respectively, or over six times. These reduced weights not only save expense, which otherwise is practically thrown away on freight and expense of moving on to site, but there are also contingent savings in foundations and in time and cost of erection. Thus a 2,000 h.p. turbo-generator requires only 75 cubic metres of concrete, whereas a 2,000 h.p. slow-running set requires at least 260 cubic metres or 3½ times as much. Whilst the time for erection is just about as many weeks as the other takes months. When to this is added the fact that the steam turbine can now claim to be a really efficient machine from the steam consumption point of view, it is difficult to see where the slow-running set will come in, and especially so when we consider the mechanical difficulties in building large-sized alternators. Below is a table giving some tests of turbo-generators supplied by Messrs. Brown, Boveri and Co.

TESTS OF SOME BROWN BOVERI-PARSONS TURBO-ELECTRIC GENERATORS.

[illegible]	Output.		Pressure of Steam Atmos.	Condensing or Non condensing.	Temperature of Steam deg. Cent.	Steam consumption [illegible]			
	[illegible]	Turbine h.p.				Full load.	[illegible]	[illegible]	[illegible]
Municipal Electricity Works, Elberfeld	1,000	1,500	11·5	Condensing	105	[illegible]	[illegible]	10·866	—
				Non-condensing	—	9·42	10·12	11·31	
	1,000	1,500	11·5	Condensing	105	8·61	10·76		
				Non-condensing	--	[illegible]	11·34		
Spinning Mills, Schappe	900	1,350	10	Condensing ...	250	9·6	10·5		
Schleper and Baum, Elberfeld	500	750	10	Condensing ...	250	9·0	9·9	11·1	-
Coal and Clay Works Tschopelner	400	600	7·5	Condensing ..	208	9·9	10·5	12·0	16·0
				Non-condensing	—	10·50	11·27	12·8	17·36
Rochlingsche Iron and Steel Works, Diedenhofen	380	570	10	Condensing	250	10·0	11·2	—	—
				Non-condensing	—	9·82	11·0		-
				Condensing .	—	11·5	13·0	--	
				Non-condensing	—	11·3	13·0		—
Cellulose Factory, Villach	350	525	11·5	Condensing ..	250	9·3	10·18	11·58	15·32
Municipal Power Supply, Neuchatel	300	450	12	Non-condensing	240	11·3	12·6	--	.
Marine Works, Indret	280	420	14·15	Non-condensing	—	11·58	-	—	
Municipal Electricity Works, Chur	200	300	12·5	Condensing ...	250	9·50	10·03	10·77	
Municipal Electricity Works, Heidelberg	180	270	9·5	Condensing ..	230	11·3 with 200 kw.	11·5 with 150 kw.	12·3 with 100 kw.	—

AMERICAN RÉSUMÉ.

NEW YORK, October 20th, 1903.

Electric Lighting.

A new incandescent lamp is now being manufactured which is a departure from the usual pear-shaped form containing a looped filiment. It consists of a tube about 9 in. long, within which is mounted a straight filiment having a curl at its centre to allow for expansion. The tubes are backed with a metallic casing which serves as a reflector, conceals the leads, and supports the sockets into which the lamp fits. The lamps give a single line of light, which is particularly desirable for certain kinds of illumination, such as show window lighting, lighting by reflection from the ceiling, and decorative illumination generally.

Another item of interest on the subject of electric lighting is contained in a report on the use of osmium filiments, the remarkable property of these being that up to a certain point they improve with use. From a test it was shown that at first the consumption of energy was 1·5 watts per candle power, this gradually reducing to 1·32 watts and thereafter remaining constant to the end of the 1,200 hour test. The candle power curve started with a value of about 14½ candle power, rose to 16·8 at the end of 300 hours, and then fell in a practically straight line to 15 candle power at 1,100 hours. The principal drawback to these lamps is that they can be used only on low voltages, so that it is necessary to burn them in series.

It was developed from a comparative test of the ordinary lamp, the osmium lamp, and the Nernst lamp, that the average consumption in the first was 3·2 watts per candle power; for the second, 1·65 watts; and for the third, 2·05 watts per candle. On account of the widely different costs of each type, an allowance for depreciation puts the comparative costs in quite another light; the average cost of the ordinary lamp is then 0·05 cents per candle hour, that for osmium lamps 0·043 cents, and that for the Nernst but 0·035 cents per candle hour.

Burning Weeds from Railroad Tracks.

One of the most serious problems with which the railroads in the western section of this country have to contend is the removal of the rank growths of weeds which spring up between the tracks. Where natural sand is used for ballast these often so overrun the rails and ties as to hinder traffic. Hitherto the only recourse has been to dig them out with hoe and spade, a slow, tedious, and very expensive method, but now a process has been developed for burning them out with crude petroleum oil as the fuel, the work being accomplished simply, expeditiously, and at a comparatively small cost. The apparatus consists of a special iron car, having a large fire pit at its centre surrounded with oil burners, from which the flames are directed downward by compressed air, so as to envelop the weeds along the track. The car is covered with a roof to exclude rain for the protection of the heated firebrick lining of the pit.

After being taken from the supply tank, the oil is first passed through a curled hair strainer, and then heated to boiling-point, after which it is sprayed into the combustion chamber by compressed air at a pressure of twenty pounds. In dry weather the work is performed at a rate of about four miles per hour, but in wet weather the progress is necessarily slower. About one-half barrel per mile is the quantity of oil required, and the expense, including materials, labour, and the attendance of a locomotive, is $1.35 to $1.50 per mile, depending on the extent of the vegetable growth and the state of the weather. Beside the locomotive and the oil-burning car, the train includes a supply car carrying an extra stock of barrels of oil, and a boarding car for the crew. It is stated that one train will care for 425 miles of track, allowing three burnings six weeks apart.

Metal Welding by Electricity.

It has been stated that the success achieved in the matter of electric welding in the United States has attracted attention abroad, and that the process is about to be adopted in England and on the Continent. It may therefore be of interest to say something of the nature of the work being done here, especially by the Thomson Electric Welding Company, of Lynn, Mass.—one of the pioneers in the manufacture of apparatus for welding, tempering, annealing, brazing, forging and shaping of metals by electricity. Machines are now in operation for making fencing and wire fabric in a variety of meshes. In this way the stay and strand wires are electrically welded at the points of contact, the advantages claimed being that a greater rigidity is secured, that a more attractive appearance is presented than by the twisted joint, and that the production is cheaper since less wire is required, and the process is more rapid. Aside from fencing, the wire fabric is meeting a demand in concrete and similar work, where it is to some extent replacing expanded metal. Electric welding is also being used for wire hoops for barrels and small wooden tubs and pails. Flat hoops welded by electricity are fast replacing riveted joints, since they are stronger, and the electric welding of chain links is coming into use, especially in the smaller sizes of the better qualities of chain. The links are first formed and strung in a continuous chain, which is then fed through a machine which thoroughly welds each link, the weld being made at the side instead of in the neck of the link. Screws, bolts, etc., are now made by welding the hexagon, round or square heads to a round cold rolled steel shank on which the thread is cut, one advantage being that a harder thread is secured than where the shank is turned from larger stock. A large amount of automobile and carriage hardware is also similarly welded,

and the welding of street car rails is becoming more general. This work has been going on in some of the larger cities for some time, and it is stated that on new rails the joints are invariably satisfactory, while on old rails only about 0·5 per cent. have proved defective, this being due for the most part to the presence of the old bolt holes in the ends of the rails where hidden cracks have tended to develop breaks. The fact as shown by test, that the conductivity of electrically welded joints is higher than the rail itself has done much to substantiate the claim that less power is required to operate a system on which the rail joints are welded.

Traction Locomotives on the Desert.

For many years the inability of horses and mules to withstand the tremendous heat and dryness of the arid Mojave desert and Death valley made transportation over thousands of waste acres in the Far West impossible. Now, however, the traction engine has been resorted to to accomplish the hitherto insurmountable task, and, as a result, new fields of wealth have been opened up. Already huge quantities of borax and salt with which these lands abound have been shipped by this method to points where they may be taken up by more efficient carriers, and it is a matter of fascinating speculation to the sanguine as to what the ultimate outcome may be with this method for developing the unknown resources of these regions.

The traction engine used is described as measuring from fifteen to eighteen feet in height, and of the three-wheel type, having two immense driving-wheels over eight feet in diameter with a smaller steering wheel located in front of the drivers. The wheels are from 24 in. to 60 in. in width, depending on the nature of the ground to be traversed, and are of exceptional strength. The tyres are of ⅞-in. open-hearth steel, and are connected to the massive hub by tension steel spokes after the manner of a huge bicycle wheel. A 6-in. steel axle supports the enormous weight and also connects directly with the draw-bar, so that the maximum tractive effort is secured. After discovering the impracticability of a horizontal boiler in a hilly country, a type was evolved which is a modification of the vertical and horizontal boilers, while the fire-box is similar to that of a locomotive. Some of the older firms employed chain gears, but these have been discarded in favour of steel cog gearing on account of its greater stability and enduring qualities. Among its remarkable features the most wonderful is the ponderous, yet delicate steering apparatus, which is so nicely adjusted that a child may operate it. This is effected by a ball-bearing in the friction part of the gear, consisting of twenty ⅞-in. steel balls, so that the steel monster is extremely tractable.

Trains for the New York Subway.

Already tests have been made on the elevated railways of the cars which are to be used on the underground road by the Interborough Railway Company. The cars are to have unusual fire protection, and a most complete system of automatic brake control. Some interesting features of the latter have been made public by the general superintendent of the Interborough Company, Mr. Frank J. Hedley. The trains will carry two lines of pipe for the compressed air; a main reservoir line charged to 90 lb. per square inch, and a train-line pipe in which a pressure of 70 lb. will be automatically maintained. Any reduction in this train-line pressure occurring while the train is in motion will cause the brakes on the entire train to set simultaneously, and the same will happen if at any time while current is passing through the motors, the motorman should remove his hand from the controller, the current being automatically cut off from the motors at the same time. Beneath each motor car will be installed the electrically-driven compressors, and the entire train will be provided with what are known as conductor's valves, by means of which any conductor on any part of the train can set the valves immediately. There will also be automatic stop valves on each truck, which will cause the current to be shut off and the brakes set if the motorman should run past a danger signal. In place of gates there will be sliding doors in the vestibules which will be opened and closed by levers, and the windows will be opened from the top instead of the bottom. Each train will be composed of five motor cars and three trailers. At present five hundred of these cars are being built.

A Large Smelter Chimney.

From the standpoint of volume of gas discharged, the new chimney at the Washoe Smelter, at Anacond, Mont., will be the largest in the world. Others are taller, but their diameter, and consequently their capacities, are smaller. When completed the base of this stack will be 45 ft. square, while the top will be 36 ft. in outside diameter, 300 ft. from the ground, and 6,182 ft. above the sea level. A flume 2,677 ft. long will convey the gases from the roaster to the base of the stack, and be the cause of precipitating much of the poisonous matter usually thrown into the air. Arsenic is one of these impurities, and it exists in such large proportions in the smoke that plans for a possible refining of this as a by-product are under consideration. The chimney will be constructed of red brick and concrete, and is expected by its great elevation to carry the noxious fumes from the smelter to the upper air currents, where they may be thoroughly and harmlessly dissipated.

Concerning Mining Accidents.

Mining accidents due to combustion within the cylinders of air compressors and the means for avoiding them, are discussed by Mr. W. L. Saunders in a recent contribution to the transactions of the American Institute of Mining Engineers. As a primary precaution he recommends the use of a compound compressor, in which the air is compressed by stages to reduce the maximum temperature, and consequently the liability of igniting the oil in the cylinders. By supplementing this with the use of inter-coolers between the cylinders the danger is still further reduced, and if care is taken to select a good grade of oil—*i.e.*, one having a high flashing point and little tendency to coke—the safety is all that can be desired. To be non-coking the oil must contain little or no carbon. This may be readily determined by placing a little of the oil on a shovel and holding it over a fire until it has become entirely volatilised, when there should be no appreciable residue of soot. Whatever oil is used should be used sparingly, certainly not more than one drop every five minutes being allowed to a cylinder of ordinary size. To remove any deposit that may collect, the cylinders should be cleansed once a week by the introduction of soap suds, which may be done through the regular oil cup, but the oil-feeding should be resumed before the compressor is stopped to prevent rusting. The valves and restricted air passages should be frequently examined and the deposits removed. Where possible the air intake should be from outside of the engine room, as this not only increases the volumetric efficiency, but lowers the maximum temperature during compression. The air is also more apt to be pure if taken from out of doors, but in any event may be improved by the use of an after-cooler to condense and collect impurities and lower the temperature of the air before it is admitted to the mine.

Mammoth Annealing Ovens.

Two annealing ovens of unusually great capacity have lately been erected as part of the equipment of the North-Western Malleable Iron Company, of Milwaukee, Wis. Each oven holds 99 pots; 55 pots being three rings high, and forty-four three and one-half rings high. The construction of the ovens required about 1,700 cubic feet of concrete, 82,000 common bricks, 60,000 fire bricks, twenty-eight tons of cast-iron plates, one ton of bolts, nuts and washers, and ten tons of I-beams. They are supported on a 12 in. concrete foundation, over which are laid five courses of common brick, and upon these rests the fire-brick paving of the return heat flues. The latter are enclosed in the fire-brick piers which support the oven floor, and the floor is covered with two courses of hard burned selected fire brick. Fire brick is also used for the arches and fire walls, and together with common brick for the side walls. Each oven has a grate surface about thirty square feet in area, and is fired from the rear. For the best economy it was decided that a draft pressure of 1½ in. of water should be used, in accordance with which the ovens were designed. Principally because the neighbouring ground was not capable of supporting a brick stack of the required height to produce this pressure, an induced draft system was installed. The fan is 110 in. in diameter, and is direct-connected to a 6-in. by 6-in. vertical inverted engine supplied with steam from a 30 in. by 8-ft. boiler. Results of a gratifying nature have been secured, 500 lb. of coal per day having been found to be enough with one furnace running and 900 lb. with both, while the evenness of the heat distribution is so perfect that hard castings, even in the end pots, are exceptional. The plant is one of the largest malleable iron works in the world, having a capacity of eighty-five tons daily, almost entirely of small castings.

SOUTH AFRICAN RÉSUMÉ.

JOHANNESBURG, October 20th, 1903.

A Proposed Zululand Port.

A scheme has been recently put before the Natal Parliament for the creation of a new port at the mouth of the Umhlatusi River in Zululand. Mr. C. W. Methven, M.I.C.E., reported some time ago that there would be little difficulty in dredging out the channel to a depth of at least 15 ft. at low water. Besides affording a suitable entrance, he estimated that the area included in the harbour would thereby be increased to about ten thousand acres at high water. The total estimated cost of the harbour works was put at £800,000.

A railway from this port will enable Natal to compete with Delagoa Bay for the Rand traffic on equal terms as regards mileage, and it will also open up agricultural and mineral country in its course through Zululand.

Still the Labour Question.

This crops up persistently in every branch of progressive activity, like King Charles's head in Mr. Dick's manuscript, and it is a sufficient excuse for referring to it, that the solution of the difficulty will add greatly to the engineering work carried on in the Transvaal. It will, therefore, not only relieve the present local depression, but would soon lead to a demand for men and material from Europe and America, especially, of course, from Great Britain. The situation may be summed up in the following manner :—

(1) The *future* progress of the new Colonies during many years must depend largely upon the mines and the extension of mining.

(2) Their *present* prosperity depends *entirely* upon the mining industry.

(3) All the efforts made to attract and retain Kaffir labour have not yet realised the number of boys required to supply and work the existing mills at their full capacity.

Therefore, it seems absolutely essential to the expansion of the mining industry and the consequent prosperity of the people, both Boer and European, that an adequate supply of unskilled labourers be imported into the country. This will not only render possible the working of new mines, but also, by lessening the present keen competition for Kaffir labour, it will enable the farmers to obtain a supply at moderate rates, cheapen the cost and increase the rapidity of railways construction, and facilitate all kinds of private enterprise.

Of course, if Asiatic labour is to be imported, everybody is agreed that it must be done systematically and under strict regulations, the most vital of which undoubtedly is the provision that the indentures of the imported labourers shall not expire until they have arrived again in their own country.

Transport Gear in Stopes.

In mines where the inclination of the lode is so flat that the ore cannot be dropped in the usual way down passes to the main level, it has been the custom here, on the Rand, to shovel the ore down the stope. The present scarcity of labour has, however, emphasised the desirability of introducing some mechanical device for the purpose. One such gear is in use at the Geldenhuis Estate mine, it having been devised by Messrs. Henderson and Tucker. It is merely an adaptation of the ordinary system of overhead ropeway, but it is arranged so that it can be readily removed before blasting and rapidly replaced afterwards.

A wire rope of about ⅝ in. diameter is attached to a plug in the roof of the stope immediately over the box hole or pass to which the ore is to be delivered. The other end of the wire rope is strained on a temporary column placed in any part of the stope, from which the broken ore is to be removed. A car of 3 cubic feet capacity hangs from a carriage with two pulleys which runs on this rope, and to this car is attached a light hauling line, operated by a small air winch which regulates the descent of the car and draws it back again after it has automatically discharged itself into the ore box. For long distances intermediate poles to support the strained rope are put in about 60 ft. apart.

The following figures are given to illustrate the economy in labour which has been effected in this mine during the last twelve months, part of the saving being due to the gear just described :—

	Ore raised during month	Total number of Kaffir boys in mine.	Tons per month per boy.
August, 1902 ...	300	9.467	24·27
July, 1903 ...	405	13.416	33·12

Another Electric Rock Drill.

The Gardner Electric Drill, which is an American invention, is now being practically tested in the United Ivy mine at Barberton.

The drill weighs 150 lb., it is 18 in. long, and is driven by a separate electric motor through a flexible shaft. The driving mechanism includes a cam and two springs, which allow of a stroke of 2½ in. at the rate of about five hundred blows per minute. It is working upon holes 5 ft. in depth, from 2 in. diameter at commencement to 1 in. at the end.

It is said to put in about 2 in. per minute with about 1½ h.p., when working at the above rate.

GERMAN RESUMÉ.

BERLIN, October 10th, 1903.

The Spindlersfelde Electric Traction Experiments.

Some particulars as to these interesting experiments by the Union Electric Company have just come to hand. The Spindlersfelde-Johannisthal line has been in regular operation since the 15th of August, and was inspected by a great number of both German and foreign engineers. At the present time single motor cars are exclusively run; it, however, is intended to run trains made up of two motor-cars and trailers later on. The motor-car, including the whole of its equipment, weighs 52 tons, the electric equipment being represented by 6 tons. It is fitted with two 125 h.p. motors, being mounted on the same rotary frame, one exciting system, and at each end one switching roller. The car is so designed that any desired number of such carriages may be coupled together and operated by one guard. The current is collected by two short arcs, automatic safety devices and fuses affording protection against excessively high currents. There is in addition a small transformer in the carriage, supplying the current for the pneumatic pumps, as well as the steering and lighting currents; there are no shunt resistances.

The motors, constructed by the Union Elektricitäts Ges., according to Winter and Eichberg's data, are designed for a tension of 6,000 volts and for 25 periods. They are permanently connected in series, and though their efficiency with full speed is, as a matter of course, somewhat less than the efficiency of direct-current motors, the advantage of the latter is compensated by their great energy consumption in starting.

The trolley wire of the line conveys the electric energy at a tension of 6,000 volts, the running rails serving as return. The trolley wire shows some novel features, as instead of by transversal wires the working wire is suspended by longitudinal wires in the form of nearly loose catenarian curves. From these longitudinal wires, thin vertical wires are suspended at distances of about three metres, supporting the working wire. Part of the track is fitted with one bearing wire, whereas the remainder has two such wires; experiment will show which is the better design. This arrangement of the working wire, where the latter has nearly no tension, will materially diminish the danger of a fracture of the latter. On the other hand, as the suspension points are placed at distances apart not exceeding three metres, the consequences of a fracture are at the same time notably diminished, the end of a broken wire being beyond the reach of the railway personnel.

Whereas both with the Lamme and Dr. Finzi motors, being series motors which absorb immediately only tensions below 160 volts, the electric energy has to be reduced to this low tension, the motors designed by the Union Company absorb directly any desired tension, only a small portion, viz., about the sixth part of the energy, having to be reduced to low tension. These advantages will result in smaller weights of the carriages and an improvement in the efficiency, the first point being specially important in connection with narrow gauge railways. As on the other hand, the small gauge railway motor of the Union Company is designed for 40 periods, as compared with 16⅔ of the Westinghouse and 18 periods of Dr. Finzi's motor, no difficulties will be met with in lighting the carriages. The greatest advantage, however, is the fact that alternate current railways according to the Union system may be supplied direct from the same machines designed for supply of light and power, special plants and even machines thus being unnecessary in the case of small gauge railways for light traffic.

From these trial runs great consequences may be anticipated for the electric industry. In fact, in many cases where present systems are not able to afford any sufficient saving, so as to justify electrification, the Union system is likely to be used advantageously, on account of the absence of such sub-stations as have to be superintended, the lowering in cost of the equipment of the line, as well as of the favourable efficiency of the power transmission. The scheme will be especially advantageous in connection with mountain railways, including long tunnel sections, metropolitan and suburban, as well as narrow gauge railways.

The Marienfelde-Zossen Experiments.

The Marienfelde-Zossen high-speed trial runs were resumed on Tuesday, October 6th, giving the anticipated results; whereas some days previously, a speed of 118 miles was obtained, the maximum authorised speed of 126 miles per hour was now finally reached.

This event was watched by numerous on-lookers. The morning trains, starting from the Potsdamer Platz Ringbahn station, in Berlin, were filled both with spectators and officials of the engineer corps. Part of the passengers left the train at Marienfelde, in order to attend the departure of the Siemens' car, or to participate in the trial run, this being a privilege of only a few; others proceeded as far as Lichtenrade, Mahlow, or Dahlwitz, where the trial motors were just developing their maximum speed. The managers of the military railway arrived in Marienfelde by the so-called revision train, made up only of a locomotive and one trailer; the motor car, where observations were being made by the engineers, was conducted by Dr. Reichel, Chief Engineer to the Siemens and Halske Company. A maximum speed as high as 126 miles (201 kilometres) was actually reached with a tension of current as high as 14,000 volts.

As was anticipated from the previous success, the whole of the electric equipment of the Siemens' car, in spite of the enormous strain involved by the starting

on a comparatively short section, has given satisfaction also with this remarkable trial run ; the current conductors gave quite as satisfactory results. The Marienfelde-Zossen section, 23 kilometres in length, was several times traversed in not more than eight minutes (including starting and braking), the maximum speed above mentioned being obtained throughout and 5 kilometres on the Mahlow-Dahlwitz-Rangdorf section traversed in 1½ minutes. The average speed as high as 175 kilometres per hour, would enable the journey from Berlin to Cologne (577 kilometres) to be completed in about 3¼ hours, whereas the quickest actual trains require 9 hours.

Some Further Facts about the High-Speed Trials.

After the great success of Tuesday, October 6th, these trial runs are to be continued with the car constructed by the Allgemeine Elektricitäts Gesellschaft. As a matter of course, this new car will at first be run at only about half the maximum speed recently attained, so as to establish its working conditions.

Some time ago, heavy oscillations of the poles and wires were noted, resulting in fractures and short-circuits. These drawbacks were eliminated by means of lighter contact arcs, fitted with better springs, as well as by some improvements in the arrangement of the conducting wire. The trial track has equally been completely renewed, the gravel bed having been replaced by a bed from finely pounded gravel. The heavy permanent way used with the Prussian high speed trains was employed, in connection with some special safety devices against derailments.

In spite of the enormous speeds attained, no disturbing facts were observed during the run, passengers being able to make records in writing both in sitting and standing positions. It may be noted that the air pressure produced by the speeds is about 200 times the ordinary pressure, being 200 kilograms per square centimetre.

The Passage Between Germany and Denmark by Ferry-Boat.

The ferry-boats connecting Warnemünde, Germany, with Gjedser, Denmark, have just been completed, and the regular service has been opened up. The boats are fitted with all the accommodations of modern steamships and are said to be remarkable for their steady sailing. The journey from the Continent to Scandinavia by the above route will henceforth be made by rail only, as these ferry-boats are intended to take the whole of the train and to transport it from one shore to the other, in a voyage of two hours. In addition to the increased convenience afforded by this ferry-boat service, the journey will be considerably shortened.

COMING EVENTS.

November.

2nd.—North-East Coast Institution of Engineers and Shipbuilders : Council Meeting.—Institution of Mechanical Engineers : Graduates Monthly Meeting at 7.30 p.m.—Society of Engineers : Ordinary Meeting at the Royal United Service Institute, Whitehall.

3rd.—Institution of Civil Engineers : Ordinary Meeting at 8 p.m., Great George Street ; inaugural address by Sir William H. White, K.C.B. Presentations of the Council's awards.

4th.—Liverpool Engineering Society : Opening Meeting at 8 p.m. at Royal Institution, Liverpool.

7th.—Birmingham Association of Mechanical Engineers : Monthly Meeting.—Manchester Association of Engineers : General Meeting.—Staffordshire Iron and Steel Institute : General Meeting.

10th.—Institution of Civil Engineers : Ordinary Meeting at 8 p.m.

12th.—Institution of Electrical Engineers : General Meeting at 8 p.m. at the Institution of Civil Engineers.—South Wales Institute of Engineers : General Meeting ; address by Rt. Hon. Lord Kelvin.

13th.—West of Scotland Iron and Steel Institute : General Meeting.—North-East Coast Institution of Engineers and Shipbuilders : General Meeting.

14th.—The Manchester Association of Engineers : General Meeting.

17th.—Institute of Civil Engineers : Ordinary Meeting at 8 p.m.

18th.—Liverpool Engineering Society : General Meeting.

19th.—Institute of Mining and Metallurgy : General Meeting at Burlington House at 8 p.m.

20th.—Junior Institution of Engineers : General Meeting at 8 p.m. at the Westminster Palace Hotel.—Institute of Mechanical Engineers : Monthly Meeting at 8 p.m.

21st.—Staffordshire Iron and Steel Institute : General Meeting.

24th.—Institute of Civil Engineers : Ordinary Meeting at 8 p.m.

26th.—Institution of Electrical Engineers : General Meeting at 8 p.m.

28th.—Manchester Association of Engineers : General Meeting.

30th.—Society of Engineers : Ordinary Meeting at the Royal United Service Institute, Whitehall.—North-East Coast Institution of Engineers and Shipbuilders : Council Meeting.

December.

2nd.—Institute of Marine Engineers : General Meeting at Stratford, E.

5th.—Civil and Mechanical Engineers' Society : General Meeting at Caxton Hall at 8 p.m.

9th.—Institute of Marine Engineers : General Meeting.

16th.—Institute of Marine Engineers : General Meeting.

23rd.—Institute of Marine Engineers : General Meeting at the London Institution, Finsbury Circus, at 7.30 p.m.

30th.—Institute of Marine Engineers : General Meeting at Stratford, E.

NOTES AND NEWS.

Vauxhall New Bridge Works.

There was a large attendance of the Junior Institution of Engineers on October 17th, when the Vauxhall New Bridge Works were visited. Mr. W. C. Copperthwaite, M.Inst.C.E., Bridges Engineer, L.C.C., who showed the party over, first went through the drawings, explaining all the important features of design and the methods adopted in executing the work, so far as it had proceeded. The running of the cableway erected for removing the old bridge and for building operations on the new, was demonstrated, an excellent bird's-eye view of the works being obtained from the suspended cage in which the visitors were conveyed across the river.

The new bridge will replace the old bridge opened in the year 1816, which was the first iron bridge built across the Thames. It consisted of nine cast-iron arches, each of 78 ft. span, with stone piers and abutments. With the increase of traffic the bridge, being only 30 ft. 6 in. wide, proved too narrow, and in 1895 the London County Council obtained an Act for its rebuilding. The new structure, when finished, will have five steel arches, built upon granite masonry piers and abutments. The ce-tre span will be 149 ft. wide in the clear, the two intermediate spans 140 ft. 4 in., and the shore spans 130 ft. 6 in. respectively. The work at present executed consists of the masonry of the piers and abutments of the new bridge built to a level of 9·75 ft. above O.D. The foundations are of concrete, carried down, in the case of the abutments, to about 18 ft. below O.D., and the piers about 30 ft. The masonry is of white Cornish granite, laid in courses of 2 ft. thick, and backed by six to one concrete.

The method of construction, after the old bridge had been removed, was to build dams similar to the one now visible at the Westminster abutment, of 14-in. by 14-in. tongued and grooved piles. Around these dams protective dolphins were placed for the security of the river traffic. These dolphins are still in existence. The foundations of the pier are in clay. Considerable difficulty was experienced in the case of the Westminster abutment, and of the pier supporting the Westminster central arch on the Westminster side. In the latter case, when the excavation of the foundation was nearly completed, the dam burst, and very serious difficulty was met with in its repair. It is proposed to finish the work in the following manner: The abutments will be built of ornamental granite facing to the parapet level of the bridge, but the masonry of the piers will only be carried up to the springing of the arches. Above that level they will be finished in steel work, the ends of the piers being decorated with ornamental cast iron panels. The steel ribs will be thirteen in number in each arch, and the superstructure is so arranged that the parapet of ornamental wrought iron projects over the outside ribs by means of cantilevers, which, it is hoped, will give a decorative appearance to the bridge.

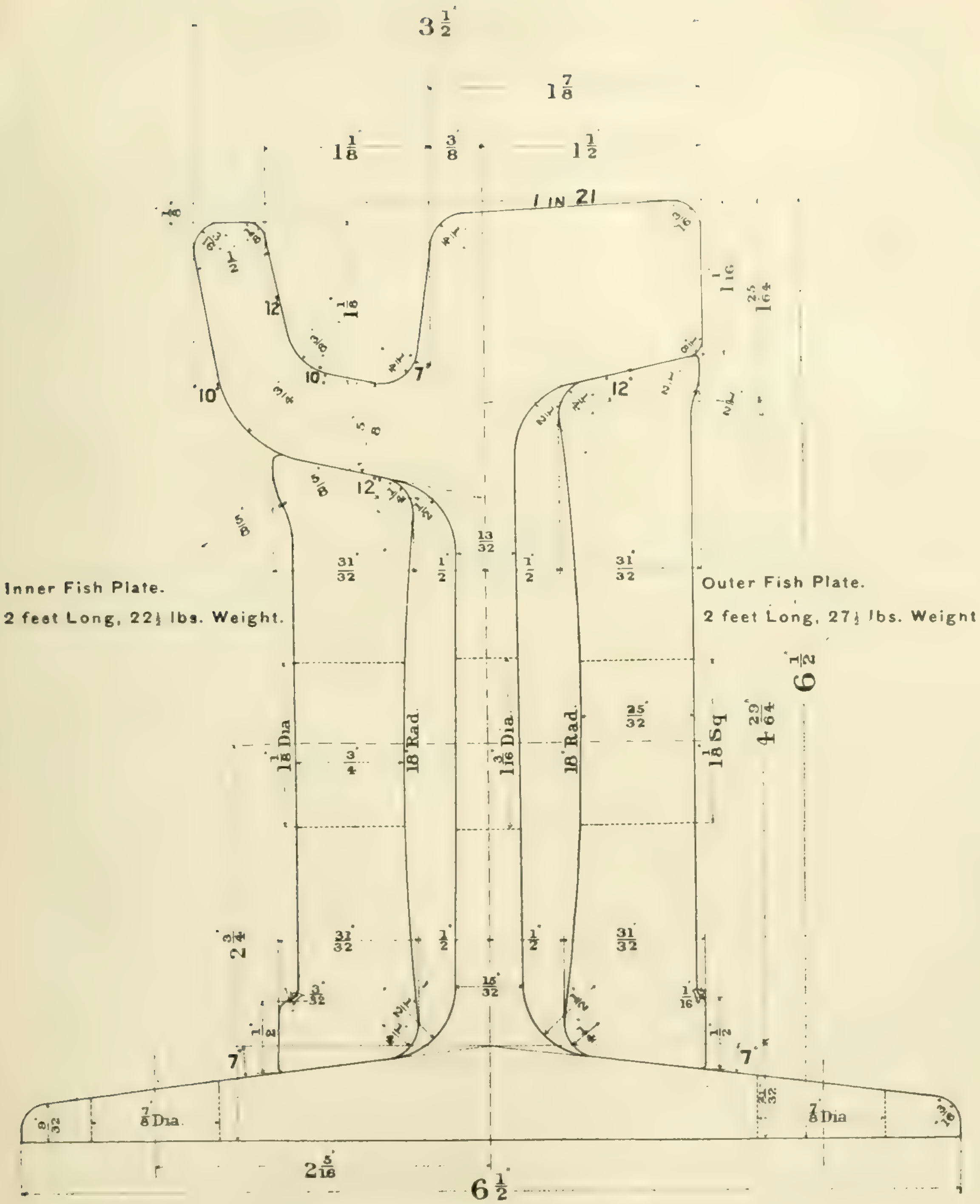
At the conclusion of the visit, on the proposal of Mr. A. F. M. Gatrill, Member of Council, a vote of thanks was passed by acclamation to Mr. Fitzmaurice (Chief Engineer, L.C.C.) and Mr. Copperthwaite for all the arrangements which had been made for the reception of the members.

C.E. Awards.

The Council of the Institution of Civil Engineers have made the following awards in respect of papers dealt with in 1902-3: A Telford Gold Medal to George Deuchars (London); Crampton Prizes to A. B. Brady (Brisbane) and G. Maxwell Lawford (London); Telford Premiums to T. Johnstone Bourne (Tientsin), R. H. Rhind (London), H. T. Hincks (Marikuppam), G. A. Hobler (Cairns), A. J. Goldsmith (Brisbane), F. H. Frere (Derby), R. Appleyard (London), P. Hamilton, B.Sc. (London). For students' papers the awards are:—The "James Forrest" Medal and a Miller Prize to Waude Thompson (Burton-on-Trent); the "James Prescott Joule" Medal and a Miller Prize to I. V. Robinson (West Hartlepool); Miller Prizes to H. A. Bartlett (London), J. D. Morgan (Glasgow), H. S. Watson (London), J. V. Thomas (Gloucester), O. B. Rattenbury (Doncaster) and C. M. Skinner (Newcastle-on-Tyne).

The Standardisation of British Tramway Rails and Fish Plates.

The accompanying specimen illustration is taken from the Tramway Rail Specification recently issued by the Engineering Standards Committee. The labours of the Committee who had this work in charge have been most satisfactorily carried out, and should make



BRITISH STANDARD TRAMWAY RAILS.
"B.S." Section No. 1.—90 lb. per yard.

it possible, after a time, to effect a free interchange of rolling stock on tramways, as on the railways, when desirable. The profiles of the rail heads are so designed that a wheel which fits one fits all. The specification includes eleven sections of rails, full size (*i.e.*, somewhat larger than the illustration).

With regard to the chemical composition of the rails, the specification provides for steel of the best quality, made by the acid Bessemer, basic Bessemer, or other approved process, and on analysis it is to show that in chemical composition it conforms to the following limits :—

Carbon,	from ..	0·40 to 0·55	per cent.
Manganese	,, ..	0·70 to 1·0	,,
Silicon,	not to exceed ..	0·10	,,
Phosphorus	,, ..	0·08	,,
Sulphur	,, ..	0·08	,,

The manufacturer is to make and furnish to the representative of the engineer (or of the purchaser) carbon determinations of each cast. A complete chemical analysis, representing the average of the other elements contained in the steel, is to be similarly given for each rolling. Such complete analysis is to be made from drillings taken from the tensile test piece. When the rolling exceeds 100 tons, an additional complete analysis shall be made for each 100 tons or part thereof.

The complete specification can be obtained from Mr. Leslie S. Robertson, M.Inst.C.E., Secretary to the Committee, of 28, Victoria Street, S.W., price £1 1s. net.

Westinghouse Enterprise.

The business of the British Westinghouse Electric and Manufacturing Company, Ltd., in the Birmingham neighbourhood, has of late attained such proportions as to necessitate the establishment of a new district office in that locality. This new branch is under the management of Mr. G. K. Chambers, formerly contract manager of the British Insulated Wire Company, and is now in full operation. The address of the new district office will be Central House, New Street, Birmingham.

Messrs. Mander Bros., of Wolverhampton, have placed with the British Westinghouse Electric and Manufacturing Company, Ltd., an order for the supply and erection of a producer gas engine coupled to a 100 kilowatt electric generator. The engine will be of the Westinghouse three-cylinder vertical type.

The Westinghouse Company are supplying for the new tramway system at Pietermaritzburg, South Africa, six complete electric tramcar equipments. These will be of standard Westinghouse pattern, each including two No. 90 series-parallel controllers, two No. 200 (35 h.p.) motors, and all the usual auxiliary apparatus, including automatic cut-out, lightning arresters, etc.

Westinghouse Magnetic Brakes will be mounted on the new electric tramcars now being built by the British Electric Car Company, the equipments having been recently ordered from the British Westinghouse Electric and Manufacturing Company, Limited.

The Institute of Marine Engineers.

The members of the Institute of Marine Engineers were recently afforded an opportunity of inspecting the West Ham electric power station, situated at Canning Town. This large station is not yet complete, but it is anticipated that within six months the whole of the buildings, together with the high power machinery, will be in working order. The visitors were received by the Mayor of West Ham (Alderman Kettle) and Mr. Councillor Byford (deputy-mayor), and by Mr. James K. Bock (borough electrical engineer). These gentlemen, and others connected with the undertaking, conducted the party round, and explained in detail the working and power of the large dynamos that are being installed. The installation at the beginning will comprise two 2,000-h.p., two 1,000-h.p., and two 500-h.p. engines and alternators for lighting ; and three 750-h.p. engines and dynamos for tramways. There are 17 Babcock and Wilcox water-tube boilers, each of which will evaporate 15,000 lb. of water per hour. The visitors were subsequently conveyed to the old station at Abbey Mills, and here, of course, everything was in full working order, although the engines were not all running at the moment. The new Canning Town station, together with the generating plant, will cost approximately £164,000, and the capacity of the plant at present on order will be 9,100-h.p. At the close of the inspection the visitors were entertained to tea at the Langthorne Rooms, when Mr. C. W. Roberts and Mr. James Adamson, the honorary secretary of the Institute, expressed the thanks of the members for their pleasant and instructive visit.

New Type of File for Gun Metal.

A new type of file, specially devised for working upon gun metal, has been introduced into the engineering department of the Chemin de Fer du Nord, France. The feature of this tool, which distinguishes it from the general type of file, is a series of shallow channels which cross its face diagonally at an angle of thirty degrees and placed about half inch apart. The raised portions of the surface of the file between these channels are occupied by the teeth of the tool. The advantages of the file are that it clogs less rapidly, and can easily and quickly be resharpened on the sand-blast, while it increases the work of the engineer who uses it in connection with gun metal filing by thirty per cent.

Tipton and Machine Tools.

Mr. John Tangye (formerly of Manchester) advises us that he has changed his address, having made satisfactory arrangements for manufacturing his new machine tools at Park Lane East, Tipton, Staffordshire.

The Junior Institution of Engineers.

Mr. J. Fletcher Moulton, K.C., M.P., F.R.S., has been elected President of this Institution in succession to Colonel Edward Raban, C.B., R.E.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

THE EDUCATION OF ENGINEERS AT HOME AND ABROAD.

A NUMBER of instructive communications have been made to the Institution of Mechanical Engineers as to the outcome of Professor W. E. Dalby's paper on "The Education of Engineers in America, Germany, and Switzerland." The following is a brief abstract :—

Dr. E. G. Coker (of McGill University) furnished some observations based upon his experience of several years at the engineering school of McGill University. He pointed out that in the States, the system of pupilage as understood in England was practically unknown. The college training was therefore charged with the duty of giving as much practical instruction as possible, and this had resulted in the equipment of fine workshops and drawing offices in addition to the laboratories, where students pursued a graduated course under suitable instructors. During the summer vacations, extending over four or five months, students were expected to enter engineering works, and as the "co-ordination between the workshops and the colleges" was extremely satisfactory, a large proportion did so, thereby obtaining further practical knowledge under actual working conditions.

Another difference between English and American schools was, that in the former a more general training was given, while in the latter the training became increasingly specialised as it advanced, until in the fourth and final year it was almost wholly devoted to one branch of engineering, civil, mechanical, electrical, mining, etc.

Mr. James E. Darbishire considered that all engineer students ought to pass through the prime-cost office. An acquaintance with prime cost and its book-keeping was the foundation of economical management—beyond this, an engineer should be instructed in correspondence, in estimating, and, if possible, in finance.

Mr. James Holden, while agreeing with Professor Dalby that the weak point in the English system was the want of co-ordination between workshop and college, pointed out that this co-ordination did exist to a certain extent in railway workshops and the Mechanics Institutions which were, in almost all cases, connected with them.

He was of opinion that the "sandwich" system, alluded to by Professor Dalby, and enlarged upon by Mr. Yarrow, formed the basis for the solution of the question. He thought, however, great care should be exercised that the amount of workshop experience was not too limited. Having in view the fact that it was desirable for employers in this country to encourage their pupils and apprentices to make a greater effort to acquire a scientific as well as a practical training, the directors of the Great Eastern Railway had recently sanctioned a scheme by which only those students who showed themselves capable and qualified to receive the higher technical instruction were able to avail themselves of it. It gave such students an opportunity which, so far as he was aware, had not yet been conceded in any other direction, namely, one, and possibly more than one, winter's course of instruction while receiving their pay, as though they were working in the shops. He thought that a lad who had served two or three years of his time in a workshop was much more in a condition to assimilate the instruction which he might receive at a technical college than one who went straight from school, and if the "sandwich" system was to be generally adopted, he would prefer that at least the whole of the first year be spent in the workshops; and assuming that a term of five years be considered a suitable one, he would divide it somewhat in the following way :—

1st year—In shops.
2nd year—First six months in shops, second six months at technical college.
3rd year—Ditto.
4th year—Ditto.
5th year—First six months in shops, second six months in drawing office.

Mr. Michael Longridge, Member of Council, feared that no entirely satisfactory scheme of education for engineers, and by engineers he meant engineers generally, could be evolved without the co-operation of the public schools and universities. A lad should remain at school long enough to experience the responsibility of ruling as well as the discipline of obedience, and he could not do this unless he remained till he were seventeen or eighteen years old, and at this age, if intending to be an engineer, he should have acquired something more than the knack of making bad Greek and Latin verses. He did not mean to say that this was the extent of the curriculum of the great schools, but he did think that the modern side should have the same prestige as the classical side, and that the teaching of the modern side should be co-ordinated as closely as possible with the science course of the university, to which he held the engineering student should next proceed. Part of this co-ordination should be the abolition of compulsory Greek at the university.

He thought there were several good reasons for proceeding from school to the university instead of to the shops, the office, or the outdoor works of a contractor or civil engineer.

First, by spending two or three years in the shops much of the knowledge, especially mathematical knowledge, which could only be kept up by constant use, would be lost, and would have to be acquired afresh.

Second, the habit of application to books would be lost, for he did not believe in night classes for growing lads after a full day's work.

Third, without the scientific training of the university, the apprentice would not learn from his practical work one quarter of what he would learn after having received this training.

Fourth, at seventeen a schoolboy was too young to be emancipated from all control, to live in lodgings and associate with workmen, with profit either to himself or them.

At the university the student should go through a course of study arranged to serve as a common foundation for every branch of engineering, so that on taking his degree he might be equally fit or unfit to enter either, as opportunity might occur. This course should be chiefly theoretical, following the German rather than the American system, and should include drawing and book-keeping. A certain amount of laboratory work in illustration of the subjects taught would be useful, but any attempt at making the student into a fiftieth rate handicraftsman should be discouraged. Specialising should not be compulsory, first, because few knew during their university course in what branch of engineering they would find an opening; and, secondly, because for a very large number special courses would, either for want of ability or lack of money, be useless or burdensome.

After leaving college the student should begin his practical working life as an apprentice, and it was then that engineers would be called upon to give their help. The duration of the apprenticeship would require consideration. He thought two or three years sufficient even for mechanical engineers, as he did not consider it necessary for men who were to earn their bread by their brains to waste time in attempting to become expert workers with their hands. He thought that to compel an engineer, as distinguished from a mechanic, to learn to file straight was as much an anachronism as to insist that he should learn Greek.

After finishing their apprenticeships of two or three years, those who were capable of it, and minded so to do, should have the opportunity of taking special courses in one or other of the various branches of engineering, either at one of the universities or at a special central engineering college, where the coping-stone of the educational edifice could be put on by the best men and with the best apparatus money could procure. He felt very strongly that any course of engineering education which must be taken in its entirety by all would be a mistake, for it must give to some less than they required, and to others more than they could digest, and above all he thought that while the education of all classes engaged in engineering, and indeed in all business, was desirable, the education of the leaders was incomparably more important; and if all the money wasted in engineering apparatus in technical schools had been spent on a central engineering college for the higher teaching, the finishing education of the leaders and the advantage to all classes would have been far greater.

Mr. T. Hurry Riches, Vice-President, wrote that he did not agree with the "sandwich" system suggested by Professor Dalby, but he quite thought that every mechanical engineer should be scientifically educated. It appeared to the writer that the remarks made at the meeting were too confined to the masters of the future and to the youths who could afford to pay college fees, and that the poorer financially did not get the consideration which they should. He was always proud of the fact that some of the best men he had turned out, including some of the Whitworth scholars, were sons of his workmen, and several of these were to-day holding responsible positions as locomotive superintendents, etc.

Mr. C. E. Stromeyer wrote that it was essential to the success of our future engineering managers that they should come in contact with the British workman at as early an age as possible, in order to acquire an instinctive knowledge of him; and if this plan was adopted, or rather, if it were continued, for it is still the rule, then something should be altered in his early education so as to remove the roughness which seems to be one of the characteristics of many, if not of all, really successful mechanical engineers.

Engineers should drop the classics out of their sons' school subjects, and should replace them by the rather more expensive general and scientific ones. Then, on entering a factory, even at an early age, a boy would at once feel that his fellow-workmen did not know very much more than their very limited trade, and he would neither look up to them nor copy their language and manners. Such a boy would grow up to be both a thorough engineer and a gentleman.

If Mr. Yarrow's "sandwich" system were generally introduced, it seemed to the writer doubly important that all unnecessary learning of dead languages and dead mathematics should be banished from those schools in which engineers received their elementary teaching; and as he wished every success to Mr. Yarrow's system, and yet feared that serious difficulties were opposing it, he would make the additional suggestion that the changes from workshop to college and back should take place not every six months as proposed, but every twelve months.

Professor Henry Spooner thought it must be generally conceded that every system of training was a compromise to which some exception could be taken, and it seemed to the writer that of all the systems that were in operation or that had been proposed, the "sandwich" one was the best; but not the one that had received so much attention lately (the alternate slices in that being much too thick to be properly assimilated), but the one in which each day more or less represented a sandwich, the early part of the day, whilst the mind was fresh, being devoted to lectures, laboratories and class work, and two or three hours in the afternoon to the workshops. There was then no appreciable break in the continuity of the scientific training throughout the year (with three terms), and the student was kept in constant touch with the workshop. No one would seriously suggest that the college workshop could ever replace practice in the shops of a mechanical engineer, where the commercial factor was so important, but experience had proved that with a well-equipped workshop, good practical instructors, and a succession of interesting jobs, students could be taught in a three years' course to do very good work at the bench and lathe, indeed, they were generally able, when entering works after their college course, soon to take the lead of those who had spent the whole of the same number of years in the works.

At the Polytechnic School of Engineering, London, the writer had had seventeen years' experience with the above system, and the results had been exceedingly satisfactory.

The writer feared that, when comparisons were made between the Technical Colleges of this country and the palatial ones in America, Germany and Switzerland, to the detriment of the former, it was often overlooked that our splendid system of Science, Art and Technical Evening Classes, was probably unsurpassed by any in the world. So long ago as 1825, before they were developed by the fostering care and

public spirited support of the Board of Education, they excited the admiration of that famous educationalist, Baron Charles Dupin, who did all in his power (with great success for a time) to develop and emulate the system in France. Were it not that apprentices and young draughtsmen mechanics who availed themselves of these classes were handicapped by coming to them after a long day's work, and that they could not attend for more than three hours each evening, they would have in this system something approaching an ideal "sandwich." And the writer ventured to think that in considering the broad question of the education of engineers, this most deserving class, a class from which so many distinguished men had sprung, and upon which the success of every works so much depended, must receive more than passing attention. He therefore heard with much pleasure the sympathetic remarks of Mr. Aspinall and Mr. Drummond (and of Sir William White and Mr. Yarrow at the Naval Architects), on the training of the young workers, whose only chance of getting a scientific education was by attending evening classes, and he trusted that it would be found practicable to do something to increase their opportunities of attending such classes. In the first place, this could be done by not calling upon any apprentice or young mechanic who was attending evening classes to work overtime, and better still, if the deserving ones could be allowed to leave off a little earlier on class nights, or start a little later the following morning, it would, doubtless, greatly increase their opportunities and efficiency. Many apprentices in the London district every year were compelled to give up their classes through having to work overtime; indeed, some very bad cases had recently come under the writer's notice, where apprentices in some of the best-known works had been kept at work three or four nights a week till nine o'clock, and even later.

If Mr. Yarrow could see his way to induce the masters to make such a concession he would be doing a great service for the country, and one that the writer had every reason to believe would be very much appreciated by a most worthy class.

THE FUTURE GOLD PRODUCTION OF WESTERN AUSTRALIA.

At a recent meeting of the Institution of Mining and Metallurgy, Mr. Herbert C. Hoover contributed a paper on the Future Gold Production of Western Australia :—

That part of West Australia declared as goldfield, for administrative purposes, has an area of 332,773 square miles, containing thirty different administrative districts, and embracing some sixty mining centres. Although this area does not embrace all the gold mining region in the Colony, still it is three times the size of the auriferous area in California, and twice the whole area of the Transvaal and Orange River Colonies combined. The deposits are widely distributed over this area, and although Kalgoorlie district produces 54 per cent. of the total gold output of the State, it possesses but 7 per cent. of the total number of properties which produced ore in 1902. No one district possessed more than 9 per cent., and it is therefore not a State entirely dependent on the ephemeral existence of one mining camp. As showing the great number of localities there are which have been found showing gold of some value, it is interesting to note that prospectors have found sufficient hope to warrant the not inconsiderable expenditure involved in application, and holding for some period, of over 7,000 different reefing leases, making an aggregate area of about 2,000 square miles of actual mining ground. Of these leases, some 2,500 are still being held, in face of the expensive rent and labour conditions, and in 1902, 1,333 properties produced ore. Of the total number of reefing leases taken up, over 2,000 have produced ore for treatment. The great majority of this 2,000 could not be dignified as mines, yet their very numbers indicate a vast recruiting ground for sound and lasting production.

The total production for 1902, from the 1,333 properties, was 2,117,241·01 oz. The total of fine gold was 1,819,308·12 oz., its sterling value being £7,727,930. The amount of ore treated was 1,888,950·12 tons. Of the total output alluvial and specimens furnished, 30,196·81 oz. bullion.

THE POSSIBILITIES OF A SECOND KALGOORLIE.

The question often arises as to whether West Australia is fully prospected, and the possibilities of discovery of a second Kalgoorlie are often discussed. The discovery of a second deposit of this sort will probably be a second accident, and with 90 per cent. of the known auriferous area wholly unprospected, and the remaining 10 per cent. not entirely prospected from the standpoint of this class of deposits, such an accident does not seem unlikely.

The water difficulty, which seemed at the outset of the gold discoveries to be an almost insurmountable obstacle, is now no longer so, as water is secured by sinking in mines or the dry lakes. The invasion of the prospector into the region outside the declared goldfield is, however, necessarily slow, because water facilities are of very gradual extension.

MINES WITH UNCERTAIN PROSPECTS.

There are eighty-four mines of more or less regular output and uncertain prospects, yet with some sort of treatment equipment. These are scattered over twenty-three districts; they possess plants amounting to 858 stamps, and occasionally other sorts of plant, such as Huntington mills, Tremain stamps, etc.—in stamps an average of ten per mine. They have variable outputs averaging about 35,000 tons per month for 25,000 oz. of bullion.

Most of this group (over 90 per cent.) are working on normal quartz-filled fissure veins, and mining short chutes of rich ore. In blaming the supposed erratic character of West Australian quartz mines, but few people seem to have realised that quartz mines the world over are not high grade mines, and the high working cost in West Australia, limiting as it has the workable portion of a vein to what would pass for a bonanza in the other great quartz regions, necessarily brings the limitation of the mines themselves to the well-recognised limitation of bonanza elsewhere. If ore of the same grade—say 4 cwt.—could be worked in West Australia, as in California, there would be no complaint as to the size of the ore chutes or their continuity in depth. A large portion of the feeling of disappointment in the field existing at present is therefore due to an exaggerated estimate formed when the richest ores were adopted as a standard of future values, instead of as local aberrations to be accepted cheerfully, but without unduly sanguine hopes of speedy repetition. California would have been a short-lived region indeed if it were to have attempted an average output of even 8 dwt. per ton, whereas the quartz mines of West Australia now yield an average of nearly 16 dwt., and for many years exceeded an ounce average.

PROSPECTIVE ECONOMIES.

These ores are practically all free milling, easily cyaniding ores, and in the handling of such it is really possible to work for a not unreasonable cost, even under present conditions, were greater skill and experience brought to bear on the problem. The average cost on the Great Fingall, Sons of Gwalia, and Cosmopolitan Mines, including redemption of development and all charges of every character, except tax on dividends, now averages 23s. per ton, and these costs will be reduced to probably 20s. or 21s., within the next two years.

THE SIXTEEN LARGE MINES.

The sixteen large mines which now form the backbone of the industry contributed in 1898 41 per cent. of the total output of the State. In 1902 this production had increased to 62 per cent., and in 1903 will probably exceed 63 per cent. During the period from 1898 to 1902 the output of the State increased by 104 per cent., and this group furnished 89 per cent. of this increase.

This group paid £1,330,327 in dividends in 1902, being 93 per cent. of the total dividends paid by public companies. The dividends represent but a portion of the actual profits, for very large sums were spent in equipment and in development in advance of extraction requirements. The dividends for 1903 from this group should exceed £1,800,000, and for 1904, with increased plant in course of erection, should swell this total to over £2,100,000.

The immediate future of the State production depends largely upon this group of mines, which are on an average only exhausted to a depth equal to less than 425 ft.

It would be possible to directly calculate the yield per foot in depth for the group, were it not for the error which the excess proportion of oxidised ore would introduce. Particularly at Kalgoorlie, there was considerable superficial enrichment, and thereby expansion of the ore-bodies in the oxidised zone. How important this was may be judged by the fact that along five lodes where it was most pronounced there were 12,500 ft. in length of stopes in the oxidised ore, against 8,700 in the sulphides immediately below—the depth of oxidation, varying usually from 150 ft. to 200 ft., the deepest being the Brownhill at 300 odd feet. If we disregard the factor of excess of oxidised ore, we have an average of 7,534 tons per foot of depth, for 9,391 oz. fine gold, or an average value of £39,688 per foot. By carefully compiling, wherever possible, the oxidised ore and sulphides separately, and estimating those instance where the results are not available, the result for sulphide ore comes out at 7,100 tons per foot, for an average of 8,270 oz. fine gold, valued at close to £35,000. This estimate will be rather under than over, first, because of the conservatism of the estimate, and secondly, because in several mines there has been undoubted improvement in depth. In making this estimate, the mines have not necessarily been considered individually, but estimates have been based upon the lodes or veins; for instance, grouping the Brownhill, Northern Blocks, Oroya as one property.

THEIR FUTURE.

With the treatment plant now erected, and in erection, which will treat about 112,000 tons per month, an average of 177 ft. of depth would be exhausted per annum. As a minimum, if an average depth of 400 ft. could be expected for annual extension of developments, it is evident that the mines as a whole are not over-equipped and will certainly warrant increases in the future of fully 50 per cent., thus giving an annual output eventually of 2,100,000 oz. of fine gold. Such an increased extraction would exhaust the mines to 4,000 ft. in thirteen years. Whether this result will be attainable, and for how long, depends entirely upon continuity of the deposits in depth, for no doubt the feverish demands of London companies will cause the production facilities to keep full pace with the size of the mines.

Taking into consideration the general structural features, the extensive width and continuity of the lodes, their undoubted origin from profound and far-reaching earth movements, there can be no doubt as to their continuity in depth. That ore will occur continuously with the lodes is a matter which permits of less finality. There can be no doubt as to re-occurrence to a further depth equal to two to three times as much as has already been exhausted. The great improbability from the general structure of the region of any alteration in the conditions which have brought about deposition at the horizons now exploited argue strongly for continuity indefinitely below. In the minds of the author and his associates in daily professional work with the mines, there is felt great confidence in the permanence of the Kalgoorlie deposits in depth.

The sixteen great mines of the Colony will in themselves, on even present showing, bring about a great expansion in the Colonial product, and should, with permanence in depth—toward which every evidence points—in themselves maintain a great output for many years to come.

THE NEWCOMEN ENGINE.

A CAREFULLY compiled paper on the Newcomen engine was recently contributed to the Institution of Mechanical Engineers by Mr. Henry Davey, Member of Council.

The events in connection with the subject were incidentally given in chronological order, as follows:—

1698. Thomas Savery, of London, obtained a patent for raising water by the elasticity of steam. Savery's engine had no piston.

1702. Savery's "Miner's Friend" published. Savery's advertisement in *Post Man*, March 19th to 21st, notifying that his engine may be seen at work "at his workhouse in Salisbury Court, London." This advertisement was printed in *Notes and Queries*, January 27th, 1900 (9 ser. v. 64).*

1712. Newcomen erected an engine near Dudley Castle for a Mr. Back, of Wolverhampton. This engine had a water-jacket around the cylinder condensing the steam, but afterwards injection in the cylinder was adopted. All valves worked by hand.

1712 to 1718. A buoy used to give automatic action to the injection-cock.

1714. A Newcomen engine, said to have been erected at Wheal Vor in Cornwall, and another at Ludgrove in 1720.

1715. Savery died in London.

1717. December 29th.—Calley (or Cawley) died whilst erecting an engine at or near Ansthorpe, Yorkshire. This is from the burial register of Whitkirk. *See* Farey's "Steam Engine," page 155.*

---

* These and some other notes have been contributed by Mr. Richard B. Prosser.

1718. Beighton invented the "hand-gear." The steel-yard safety valve was introduced, also the snifting valve and the shortened eduction-pipe with its non-return valve. All the essential features of the perfected engine were now present.

1720. Newcomen went into Cornwall and erected an engine at Wheal Fortune Mine. Another engine on the same model was erected at Pool Mine in 1746.

1721. An advertisement in the *Daily Courant*, July 24th, 1721, beginning "Whereas an engine to raise water by Fire, commonly called Savery's engine . . .," and inviting attention to a new form of engine. The above was printed in *Notes and Queries*, January 27th, 1900 (9 ser. v. 64). See also *Notes and Queries*, February 17th, 1900, for a communication from J. E. Hodgkin.*

1725. Joseph Hornblower erected an engine at Wheal Rose Truro; a second engine was erected at Wheal Busy, and a third at Polgooth.
April 8th.—Steam engine at work at Tipton, Staffordshire. [On this day the son of John Hilditch, "Manager of ye Fire Engine at Tipton," was baptised in the Parish Church of Bilston.—*Engineer*, November 11th, 1898.]*

1729. Newcomen died in London.

1733. July 24th.—Savery's patent expires, having been in existence for thirty-five years.

1758. Many engines at work in Cornwall, one at Herland having a 70-in. cylinder. (Emerson describes in detail the Newcomen engines as then used.)

1767. Smeaton first turned his attention to the atmospheric engine.

1769. Smeaton computed the duty of fifteen engines in the Newcastle-on-Tyne district, and found the average duty to be 5·59 million one bushel or 84 lb. of coal.
January 5th.—Watt's first patent.

1770. Smeaton made note of eighteen large engines in Cornwall, eight of which had cylinders from 60 to 70 in. diameter.

1772. Smeaton made improvements in details, not altering the general construction, and succeeded in obtaining a duty of 9·5 mill.

1775. Smeaton erected a Newcomen engine at Chasewater in Cornwall, the steam cylinder 72 in. diameter. Water load 7¾ lb. Lift or pumps 360 ft. This engine was altered by Watt to his system.

1776. Watt corresponded with Smeaton and claimed 21·6 mill duty for his engines. Smeaton, after making experiments with Watt's engines, laid it down as a general rule that the Watt engines did double the duty of the Newcomen.

1777. Watt erected three more of his engines in Cornwall, his first having been erected the previous year. In these engines the load on the piston was increased from the 8 lb. in the Newcomen to 11 or 12 in the Watt engines.

1778. Smeaton found that a Watt engine at the Birmingham Canal* did a duty of 18 millions, and one at the Hull Waterworks 18·5 millions. Two engines at Poldice were found to do a duty of 7 millions on one bushel of coal.

1781. October 25th.—Watt's second patent.

1800. Watt finished his labour in Cornwall, having raised the duty of his engines to 20 millions.

* See footnote, p. 474.

1810. A Newcomen engine was erected at the Farme Colliery, Rutherglen, Scotland, for winding and pumping; in 1820 another was added for winding, and in 1821, another having a 60-in. cylinder for pumping.

The paper included a complete description of the engine, with many illustrations and valuable appendices.

SEWAGE TREATMENT.

THE following notes on the treatment of sewage are abstracted from a paper contributed by Mr. J. Woodward Hill, Associate M.Inst.C.E., to the South African Association of Engineers:—

After the sewage has been brought to the outlet works or site for utilisation and treatment, the perplexing question arises, "What is to be done with it?"

The problem, as stated by G. E. Waring, junr., is "to separate one part of organic matter from one thousand parts of water, and leave the water pure," to which should be added that the purification must take place at the works, and not on other persons' property below the works, and that the process of purification must not create a nuisance.

The methods of treatment, omitting sea outfalls, are (1) Chemical Treatment, (2) Land Irrigation, and (3) Bacterial Treatment.

CHEMICAL TREATMENT.

In 1855, and for many years afterwards, it was thought that a large profit could be made out of town sewage by chemical treatment, precipitation and conversion of the fæcal matter into artificial manure, but this idea has been gradually abandoned.

Lime, sulphate of alumina, sulphide of iron, crude alum, copperas and magnetic oxide are principally used in chemical processes; they remove suspended matter, but they do not deal with matters in solution which are readily putrescible, and they merely postpone decomposition, which is ultimately inevitable.

Chemical processes have the further disadvantage of producing a mass of sludge which is exceedingly difficult to dispose of profitably.

The chemicals are too expensive, having due regard to their want of ultimate and permanent efficiency, but they are often very useful for temporary purposes and must not be condemned as worthless.

LAND IRRIGATION.

The first sewage farm in England was inaugurated at Carlisle in 1860; the Croydon Farm at Beddington commenced in the same year, followed by that of Bedford in 1868. These farms are still running successfully and there is no test so severe as that of time.

In the early days of land irrigation by sewage the prospects of large profits from a series of magnificent crops induced the local authorities of many towns in Great Britain to embark on sewage farming as a profitable and satisfactory solution of the sewage problem, but the modern view is that profit is entirely a secondary consideration to the cleanly and safe disposal of the sewage.

Where prices of agricultural and market garden produce rule high there is a chance of the sewage farm making a profit, but under ordinary conditions they barely pay working expenses, more particularly since the advent of agricultural depression.

The sewage must be got rid of, and the farms are clearly entitled to take credit for the work of sanitation they perform.

Sewage farms require very careful management by competent men, and the manager must pay more attention to the disposal of the sewage than to good crop results.

The purification of sewage by passing it through the land is effected by broad surface irrigation, by intermittent downward filtration, or by a combination of the two methods.

The crude sewage should be passed through some filtering medium before it is allowed to flow on to the land, and its application must be intermittent to draw the air into the soil.

Broad irrigation requires about 176 acres per million gallons per day, and intermittent filtration requires about 67 acres per million gallons per day, but the acreage varies, of course, with the nature of the soil and sub-soil.

The cost of preparing land for broad irrigation in England varies from £20 to £70 per acre, and intermittent filtration areas about £85 per acre.

Where possible the separate sewerage system should always be adopted to secure uniformity of flow and better quality of sewage.

Italian rye grass is the best crop, as it will absorb any quantity of sewage, and the crops generally grown in the district are, as a rule, the most suitable for irrigation farms.

In intermittent filtration the land is laid out in consecutive ridges and furrows, the furrows being about 18 in. wide at the bottom and 3 ft. at the top, and the ridges from 2 ft. to 3 ft. wide.

There are magnificent sewage farms at Berlin and Paris. Available area: Berlin, 22,881 acres; Paris, 4,000 acres. Cow-keeping and the sale of milk are profitable near large towns.

BACTERIA.

A sewage farm is nothing more nor less than a huge bacteria bed; one may go further and say with truth that the whole world is a vast bacteria bed.

From time immemorial the great process of purification has been accomplished by extremely minute organisms called bacteria, bacilli or microbes, but their presence was only detected in 1839 by Schwann and Schultz.

Bacterial methods of sewage purification have been employed at Exeter since 1895 and at Sutton since 1896.

The population of Sutton in 1899 was 16,500, average daily flow of sewage at works half million gallons. Area of district, 1,835 acres; number of houses, 2,687. Area of land, 28 acres, of which only 18 acres are capable of irrigation.

The cost of sewage purification by chemical precipitation and broad irrigation was £15 11s. 11d. per million gallons, while by the bacterial process it was £3 19s. per million gallons.

The construction of a bacteria bed on the Sutton system, according to Mr. Dibdin, is very simple. The ground, where suitable, may be excavated and refilled with sifted coke, burnt ballast, or broken bricks that will pass through a three-inch ring. At Sutton the excavating material has been burnt and refilled without walls at a cost of £726 per acre.

In many cases walls and bottom would require to be of concrete. A one-acre filter at Barking cost £2,000.

A bacteria bed on this system will treat about 700,000 gallons per acre per day of twenty-four hours, if filled and discharged twice daily. The sewage, after passing through the first bacteria bed, is led on to a second bacteria bed of finer material, and a third bed of coarse sand may be used where the standard of purity is very high.

One hour for filling, two hours resting full, one hour emptying, and four hours resting empty is a convenient arrangement, and would give three fillings in twenty-four hours.

The sewage is delivered over different parts of the filter bed by means of wooden troughs, and pipes are laid under the filtering material to collect the effluent and lead it to the point of discharge. The time of discharge is regulated by automatic time syphons.

In the Sutton method ærobic microbes, or microbes that can live in air, are the principal agents of purification, and air is freely admitted during the process.

At Exeter, in the septic tank system, anærobic microbes, or microbes that can live without air, perform the principal work of nitrification in the first stage.

The model septic tank at Belleisle, Exeter, is covered with a brick arch, and light and air are excluded as much as possible. A considerable quantity of gas is produced from the sewage as it passes slowly through the tank, at the rate of about two feet per hour, to the ærobic beds.

It will be noticed, therefore, that although the Sutton and Exeter methods differ in the first stage, the secondary treatment is ærobic in both cases.

The experimental works were considered so satisfactory that the whole of the sewage of Exeter is to be treated on the Septic Tank System. For a population of 46,000 six tanks are provided, 181 ft. by 35 ft. by 7 ft. deep. Capacity about 270,000 cubic feet. There are, in addition, eight filters, with a total area of 13,600 square feet, each $3\frac{1}{2}$ ft. deep, with a working capacity of $2\frac{1}{2}$ million gallons per day.

The filling, resting full, emptying, and resting empty are regulated by a series of tilting buckets.

It is now generally admitted that where suitable land cannot be obtained at a reasonable price, bacterial treatment is advisable, and under any circumstances would be very beneficial to the land.

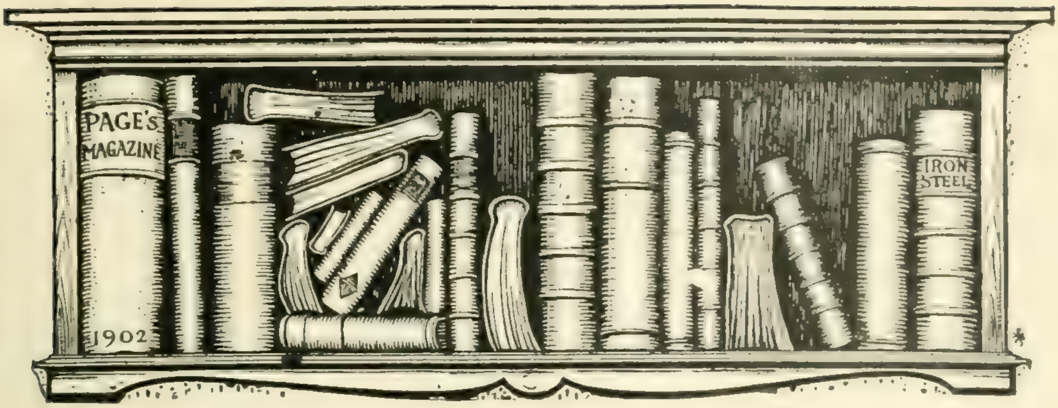
The sickening of land on ordinary sewage farms is caused by clogging the soil with organic matter in too solid a form, but by breaking it up into minute particles by bacterial treatment a splendid liquid odourless manure is produced.

The Sutton method is an imitation of intermittent downward land filtration controlled by valves, and the first stage of the Exeter system is very much like a modernised form of the old familiar cesspool.

They are, in fact, both ancient processes revived.

The essential difference, however, between ancient and modern practice is that the methods of nature are now better understood, and developed on more scientific principles.

There is no finality with regard to the treatment of sewage, but the same great principles of Nature are applicable to mines, building estates, public institutions, villages and country residences, a well as towns. The bacterial method of purification can be adopted with confidence. Bacterial treatment requires no chemicals, produces no offensive sludge, removes the whole of the suspended matter, and fifty per cent. of the dissolved oxidisab'e matter at each filtration.



BOOKS OF THE MONTH.

"THE PRACTICAL PHYSICS OF THE STEAM BOILER."

By Frederick J. Rowan, A.M.I.C.E., M.I.E.S. P. S. King and Son, London. D. Van Nostrand Co., New York. 21s. net.

In the course of this bulky but very interesting volume devoted to the modern steam boiler considered as a heat engine, the author deals more particularly with water-tube types. His endeavour has been to treat not so much of how boilers are made as to consider on what lines they may be improved. This standpoint is well summed up by R. H. Thurston, LL.D., in the course of an introductory note. The author does not seek "to learn the ratio of fuel-consumption to the grate area, but rather the philosophical datum of real importance, the ratio of area of heating surface to fuel consumed. He would ascertain the conditions of maximum efficiency both of heat development and of heat transfer. He studies the effect of varying rates of flow of furnace gases along the heating surfaces with which they are in contact, for the purpose of ascertaining the laws of heat-exchange as affecting the efficiency of the boiler as a whole. He investigates the effects of chemical and structural changes, as well as of mechanically applied stresses, upon the safety and the endurance of the boiler. In the whole work it is recognised that such a real and practical and applicable knowledge of this as of any department of engineering, must be based upon scientific fact, principle, and method; discovering by experience and direct experiment the fundamental facts, deducing by sound logic the principles of which the facts are the illustrations; then applying that knowledge of fact and those accurately defined principles to the solution of the equally well-defined problems of the engineer." The author has embraced a vast amount of authoritative information, which is presented with many useful suggestions and an elaboration of principles which should render it a notable addition to the literature of the subject. There are altogether 314 illustrations and numerous tables, the arrangement of the work being as follows: Introductory—Some Fundamental Elements of Boiler Design—Combustion—Transmission of Heat—Circulation of Water—The Influence of Temperature on Tenacity and Ductility—Corrosion and Incrustation in Boilers—Historical Sketch of Boiler Design—Some Tests of Boilers and Results.

"CASSELL'S POPULAR SCIENCE."

Edited by Alexander S. Galt. Illustrated. Cassell and Company. 12s. 6d. net. Vol. I.

We have already called attention to the excellence of this production, which now makes its appearance in bound form. The volume has a dozen coloured plates, and among articles of special interest to technical readers may be mentioned the following:—The Wizard Electricity (three articles)—What are the X-Rays?—The Phonograph—Liquid Air—Coal Gas—A Visit to a Quarry—How to make Chemical Analysis—What is radium?

"THE HARDENING AND TEMPERING OF STEEL IN THEORY AND PRACTICE."

By Fridolin Reiser, Mining Councillor, Director of the Cast Steel Foundry, Kappenberg. Translated from the German of the third and enlarged edition by Arthur Morris and Herbert Robson, B.Sc. Scott, Greenwood and Co.

This work was originally published in 1880, a second edition being brought up to date in 1895, and a third in April, 1900. The present edition has a chapter on heating arrangements for tempering steel, and methods of measuring high temperatures, the second part of this chapter being intended to create a wider interest in the pyrometer.

"THE PROPORTIONS AND MOVEMENT OF SLIDE VALVES."

By William Dyson Wansbrough. The Technical Publishing Company, 4s. 6d. net.

It is almost impossible, as the author points out, to over-estimate the influence of the slide valve upon the working of the modern steam engine, for the slightest alteration in its proportions or movement is all that is necessary to convert the best and most mechanical steam engine into a wasteful and extravagant coal eater. Some fifty problems in the proportions and movement of slide valves are here presented with a series of constructional diagrams. They originally appeared in the *Mechanical World*, but are now reproduced in book-form, and are consequently handy for ready reference. Students, draftsmen, and engineers generally, who are in search of a complete investigation of slide-valve problems, should find in Mr. Wansbrough's work a most useful aid.

"ELEMENTARY TREATISE ON ELECTRICITY AND MAGNETISM."

By G. Carey Foster, F.R.S., and Alfred W. Porter, B.Sc. Founded on Joubert's "Traité Elémentaire D'Electricité." Second edition. Longmans, Green and Co. 10s. 6d.

Much information useful to the student is crowded into the 568 pages of this work, which has been revised and in a large part re-written, so that the responsibility of the original author is less than in the previous edition. Among the principal additional matters introduced may be mentioned: The theory of electric images, as applied to the mutual electric influence of spherical conductors; a discussion of the stresses in the dielectric medium; the water-dropping electric machine; the idea of ionisation of electrolytes, and its bearing on electrolysis and allied phenomena; the propagation of electric waves along a "concentric cable," and of a plane wave in an unlimited isotropic medium; the properties of the cathode stream, of Röntgen and Becquerel rays, etc.; the Zeeman effect, and a brief account of recent investigations bearing on the theory of electrons.

"ELECTRICAL ENGINEERING MEASURING INSTRUMENTS FOR COMMERCIAL AND LABORATORY PURPOSES."

By G. D. Aspinall Parr, M.Inst.E.E., A.M.I.Mech.E. Blackie and Son, Ltd. 9s. net.

It says much for the growth of the electrical industry that 328 pages should be filled with matter devoted entirely to this one aspect of the subject, more especially as the author has only dealt with instruments in actual and extensive use. Mr. Parr remarks, it is practically only since 1880 that this particular section or branch of the industry has developed. Perhaps there is no subject connected with electrical matters at the present day which is of greater importance. In fact, it may be truthfully said that the whole electrical engineering industry, which is just now developing into such enormous proportions, owes its very existence to the simultaneous improvement of the electrical measuring instrument, without which it would be utterly impossible to successfully apply to many the principles that are now used in electrical devices, or appliances. The book is freely illustrated, and has been produced in a manner worthy of the importance of the subject.

"BONUS TABLES FOR CALCULATING WAGES ON THE BONUS OR PREMIUM SYSTEMS, FOR ENGINEERING, TECHNICAL, AND ALLIED TRADES."

By Henry A. Golding, A.M.Inst.M.E. Charles Griffin and Co., Ltd. 7s. 6d. net.

We have heard a great deal lately about the theory of premium systems, and this volume by Mr. Golding places a sound piece of practical work at the disposal of those manufacturers actually embarking on the system. A few pages only are devoted to the description of the bonus system and method of using the tables. The body of the book is devoted to figures by which anyone using the premium system may save a vast amount of time in calculating the various percentages. This careful compilation should obviate entirely the possibility of mistakes in calculating wages on the bonus system.

"THE RESISTANCE AND POWER OF STEAMSHIPS."

By W. H. Atherton, M.Sc., and A. L. Mellanby, M.Sc. Illustrated. Technical Publishing Company, Ltd. Manchester. 5s. net.

The important paper on the "Lines of Fast Cruisers," read by Vice-Admiral C. C. P. FitzGerald at the Spring Meeting of the Institution of Naval Architects, recently called attention to a subject of first-rate importance in naval design, but somewhat abstruse to the lay mind. Those who wish to gain an insight into the problems connected with the resistance and power of steamships will find the above work, by Messrs. Atherton and Mellanby an informing and useful introduction. Examples are given of almost all the recognised methods of determining the engine power required to propel steamships, and there are many valuable diagrams. A considerable section of the work deals with the fouling of ships. Illustrations are given showing the remarkable influence of fouling in sea-going ships, though some of the instances, dating from the sixties, are rather ancient. But the effects of fouling are, perhaps, too well known to need up-to-date illustration.

"WORK."

Half-yearly volume. Vol. XXIV. Profusely illustrated. Cassell and Co. 4s. 6d.

This half-yearly volume—July 12th to January 31st, 1903—has six coloured plates and innumerable articles of every-day interest to handicraftsmen. Among other features we note special articles on designing launches, building a model locomotive, splicing wire ropes, etc.

OUR DIARY.

September.

23rd.—Opening of the River Weir. Commissioners' Roker Pier at Sunderland.—The appointment of a Commission to investigate the native question in South Africa has been gazetted at Pretoria.

24th.—The Post Office announces an extension of telephonic communication with Belgium.—The government of Burma has issued a report on the trade of Yun-nan.—Administration report on the railways of India for 1902 shows a surplus to the State of nearly 20½ lakhs of rupees.—Launch of the cruiser *Hampshire* at Elswick.

25th.—The Cunard Company has appointed a committee to investigate the application of marine turbines to their new steamers.—Launch of the Turkish cruiser, *Abdul Hamid* at Elswick.

26th.—The Transvaal Government has decided that in view of the scarcity of labour the present time is inopportune for the construction of new railways.—Three French aeronauts ascend at Paris in a double balloon, reaching Hull following day.

28th.—The Admiralty have accepted tenders for the construction of three new armoured cruisers.

29th.—The proposed light railway through Northern Essex is shortly to be commenced.

October.

1st.—British Westinghouse system of electro-pneumatic signalling installed at the new Bolton Station of the Lancashire and Yorkshire Railway Company.—New installation of electric light at the Lizard, exhibiting a flash every five seconds.—Mr. S. Spencer makes a second but unsuccessful attempt to sail his airship from the Crystal Palace round St. Paul's and back.—Successful inauguration of the railway to Kumassi.

2nd.—The North-Eastern Railway Company have decided to erect a colossal siding for goods traffic at Northallerton.—Trade of India for the first quarter of the fiscal year 1902-3 compares favourably with that for the corresponding period of 1901-2, especially under exports.—The total imports of Peru last year amounted to £3,303,459, of which the United Kingdom sent a third.—Reduction of 2½ per cent. wages, South Wales Iron and Steel Trade.—Motor speed trials commence at Southport.

3rd.—Mosely Educational Commission leaves Southampton.—The Allan Line Company have placed an order for new liner to be fitted with turbine engines.

5th.—Opening of the Congress of Amalgamated Society of Railway Servants at Peterborough.—Wages in the Northumberland Coal Trade to remain unaltered during the next three months at 23¾ per cent. above the standard of 1899.—Serious dispute in the ship-repairing shops at Barry Dock.

6th.—Shipping Exhibition opened at Whitechapel.—Conference of the Miners' Federation of Great Britain opens at Glasgow.—A speed of nearly one hundred and twenty-six miles an hour attained by an electric train on the Zossen military experimental line near Berlin.—Mr. Skinner reports that the better class of Chinese labourers are suitable for work on the Rand, and that a sufficient supply of them is available.

7th.—Mr. Bryce, M.P., at Halifax argues that we need ampler provision for teaching the higher branches of theoretical science.—The Railway Servants' Congress views with dissatisfaction "the continued indifference of the Board of Trade to the application for more efficient supervision of railways.—Launch of the first-class cruiser *Carnarvon* on the Clyde.

8th.—Prof. Langley's airship, subsidised by the U.S. Government, has been wrecked.

9th.—The New Zealand House of Representatives has passed the Coast Wine Trade Bill.—Conclusion of the Conference of the Miners' Federation of Great Britain.

10th.—Mr. S. F. Cody, owing to the adverse wind, postpones his projected cross-Channel voyage in a collapsible boat towed by one of his kites.—M. Marconi, arriving at Queenstown, states that in about two months ordinary commercial and press wireless messages will be despatched across the Atlantic.

12th.—The Admiralty have given instructions for a wireless telegraphy station to be established at Felixstowe.—Seamen strike at Cardiff for a uniform port wage of £4 10s.—The new Allan liner *Victorian*, is to be fitted with Parsons turbine engines.

13th.—Report on the foreign trade of China demonstrates the recuperative powers of the country, the total imports last year being valued at £39,118,115, and the exports £30,693,946.—The Board of Trade have confirmed the following orders made by the Light Railway Commissioners :—(1) Lastingham and Rosedale Light Railway (Extension of Time) Order, 1903, amending the Lastingham and Rosedale Light Railway Order, 1900; (2) Dartford District Light Railways Order, 1903, authorising the construction of light railways in Kent, from the Thames near Greenhithe to Dartford and Eynsford, with branches to Swanley Junction and to Stansted. Project to rebuild Lambeth Bridge rejected by the London County Council.—The Bridges Committee authorised to proceed with the construction of the Rotherhithe tunnel at a cost of £1,340,000.

14th.—The total output of gold from Rhodesia for the month of September given as 18,741 oz.; for September, 1902, the gold output was 15,164 oz.

16th.—Meeting of the Coal Conciliation Board to consider a reduction of 10 per cent. on wages proposed by the coal owners, the present rate of wages being 50 per cent. above the standard rate of 1888; the parties being unable to agree, it was referred to Lord James of Hereford to decide the difference between them.

17th.—The imports into the Transvaal during the first eight months of the present year amounted to £14,280,908, as compared with £6,387,046 during the corresponding period of 1902.—Collision of the battleships *Prince George* and *Hannibal* off Ferrol.

19th.—Expiry of the Bridgwater Trust.

21st.—The award of the Alaska Boundary Tribunal is substantially in favour of the United States.—Miners National Conference opens at Westminster Palace Hotel.

22nd.—At the Miners' Conference a resolution is unanimously carried declaring adherence to and continued support of the free trade policy of the last fifty years; the following resolution has also been carried :—

"That this conference representing the whole of the miners of the United Kingdom, having considered the disease known as 'the worm,' and having heard of its terrible effects on the mining population on the Continent, and that it has been found in Cornwall and in Scotland, hereby calls upon the Government to at once take steps to meet and prevent the introduction and spread of this terrible danger to the miners, and, as a result to the whole community; and we suggest, as a preliminary step, that Government should call an immediate conference of the employers and employed in connection with the miners of the United Kingdom."

NEW CATALOGUES & TRADE PUBLICATIONS.

The following Catalogues may be obtained from the firms issuing them, if PAGE'S MAGAZINE *is mentioned when applying.*

The Cradley Boiler Company, Cradley Heath, Staffordshire.—A series of loose sheets illustrating and describing a few of the different types of boilers manufactured by the firm, for both home and export trade, including marine and land types of "Loco" boilers, vertical boilers in all sizes, Lancashire and Cornish boilers, semi-marine boilers, (suitable for electric light installations), and vertical donkey boilers, of both the cross tube and multi-tubular types.

The Vacuum Oil Company, of Rochester, Olean, U.S.A.—A neat little illustrated brochure of 66 pages and cover, entitled "Oil and Power," being a treatise on reducing friction. The author endeavours to show to the user of power that oil, whether properly applied or not, is a money-saver and maker, and goes on to point out in a convincing manner wherein lies the real value of greases and oils, and how the standard of value is arrived at. The following is one of the many quotations used from Professor Thurston: "If we could get at the rate of deterioration of any valuable machinery, driven at anywhere near its limit of power, we should have a new measure of the value of oil. The value of oil that reduces wear, in any such ratio as that revealed in this English experience, must be several hundred dollars a year, in terms of wear alone, for one locomotive."

Bertrams, Ltd., Edinburgh.—Three illustrated pamphlets, descriptive of their condensing plant, (jet, surface, evaporative, and ejector), spray and mechanical water cooling, centrifugal, and other pumps for high or slow speed, both steam and electrically driven, also machine tools "in progress and ready for delivery," including punching, shearing, and angle cutting machines, self-acting plate planing machines, improved corrugating machines, circular cutting machines, heavy plate bending rolls, a nine-roller plate straightening or flattening machine, a multiple punching machine of capabilities 24⅜-in. diameter holes through $\frac{3}{16}$-in. plate, and approximate weight, 3 tons 5 cwt. A four-page pamphlet is devoted to a description of the "Midgett" two-cylinder air compressor for electric motor or belt drive. This is specially designed for giving compressed air for dynamo cleaning, and gives approximately twenty cubic feet of free air per minute at a pressure of 20 lb. to 30 lb. per square inch, running at a speed of 230 revolutions per minute. This firm are also licensees and makers of the Edwards' Air Pump, which, we are told, has been supplied to a large number of corporations, councils, etc., throughout Britain.

Lassen and Hjort, 52, Queen Victoria Street, E.C.—Catalogue No. 3, dated June, 1903, is a 24-page illustrated booklet, with cover, bearing on the Bruun-Lowener water-softener. This is an apparatus for softening water by means of a chemical process best described by the following quotation from one of the pamphlets issued by the firm: "The water to be treated is led into one of the two chambers of an oscillating receiver, each having a triangular section, and when the one chamber is full of water the receiver tips over, pouring its contents into an intermediate tank below. No matter how much or how little water is passing through the softener, the proportion between the chemicals and the crude water will always remain the same, and consequently reliable results are ensured. The lift of the valve in the chemical reservoir can be easily adjusted by raising or lowering a nut on the valve spindle, thus allowing more or less of the chemicals to pass at each lift. After having been mixed with the chemicals the water passes into a heating chamber, where it is heated to 150 deg. F. by exhaust or live steam. From the heating chamber the water passes into the settling tank, where the foreign matters are precipitated, and from here it rises through the filter, which consists of wood wool packed tightly between two rows of wooden bars." We understand this system has been adopted in over 1,000 works in all parts of the world, including engineering works, breweries, distilleries, and many others.

The Globe-Wernicke Company, Ltd., of 44, Holborn Viaduct, London, E.C.—Catalogue No. 33 B, being an illustrated pamphlet of 26 pages, entitled "The Globe-Wernicke Elastic Cabinets — A system of units," being an exhaustive description of an ingenious device for an "expanding" filing cabinet. This cabinet is composed of a series of "units"—or small cabinets, each complete within itself, placed one above the other or end to end, each tier resting on a base and surmounted by a top, and all securely locked together into one compact and complete cabinet. These units may be furnished with a variety of interiors embracing filing devices of various kinds, drawers, pigeon-hole cases, etc. As the business grows more units can be added, and so on indefinitely, so that there is no limit to its expansion and it combines the further advantage of economy in space, it being quite unnecessary, when commencing business, to fill the office with large empty filing cabinets to provide for future development. The business or professional man whose office comprises little more than desk room, may begin with a single unit of such filing devices as he may require, and add to it unit by unit as his business expands and room increases, to an extent limited only by the space at his command. We understand it has been adopted by many business houses both here and in the United States, and some testimonials from the latter speak very highly of its practicability and usefulness.

Incandescent Lamps

OVER TWENTY YEARS' EXPERIENCE

QUALITY and PRICE RIGHT

SEND FOR PRICE LIST TO

The Brush Electrical Engineering Co Ld

Victoria Works
Belvedere Road
LONDON S E
(South End of Charing Cross Footbridge)

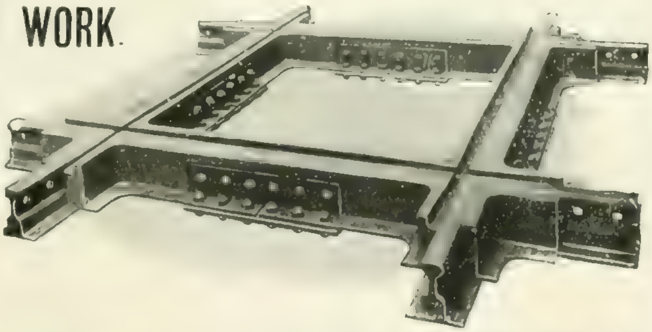
HADFIELD'S CONSTRUCT LAY-OUTS

... OF EVERY SIZE AND DESCRIPTION ...

HADFIELD'S PATENT MANGANESE STEEL

IS THE BEST MATERIAL FOR

TRAMWAY TRACK WORK.



TRAMWAY POINTS & CROSSINGS

TRAMWAY WHEELS & AXLES

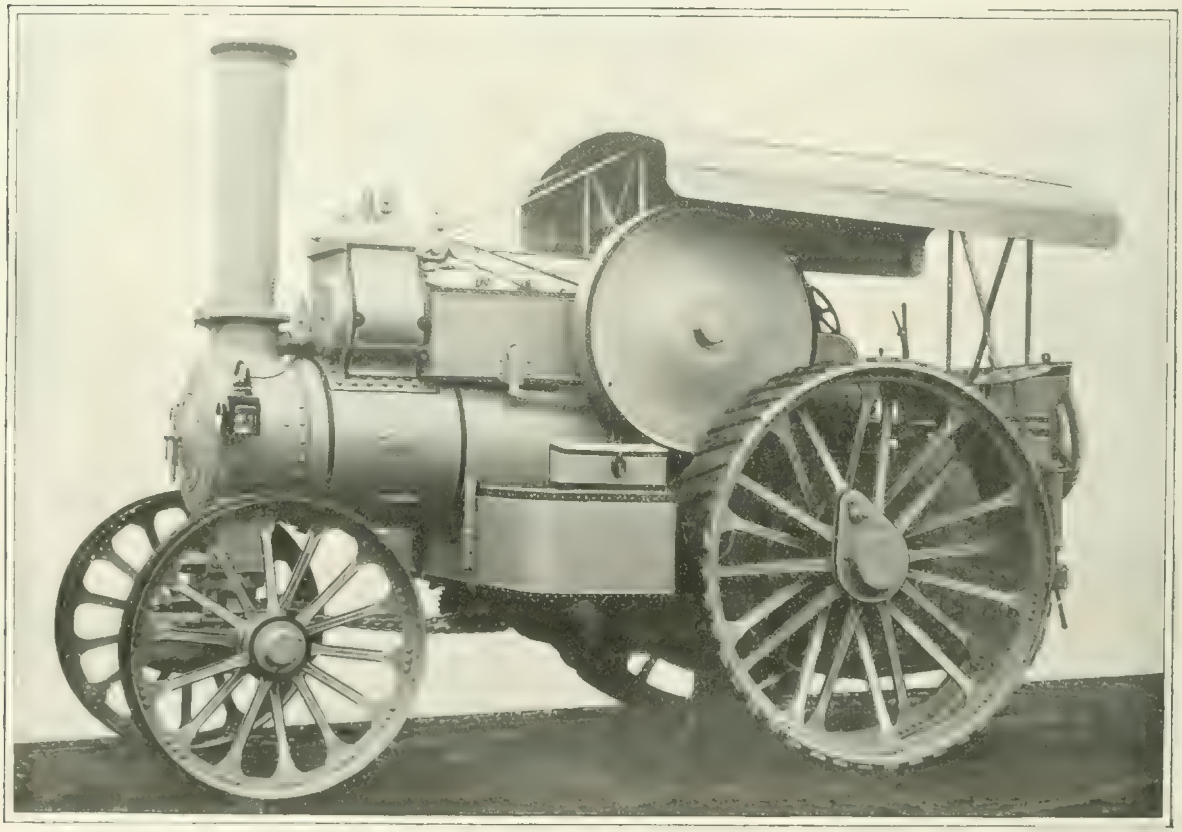
TIE-BARS, Etc., Etc.

HADFIELD'S STEEL FOUNDRY CO., LTD., SHEFFIELD.

JOHN FOWLER & Co.
(LEEDS) LIMITED.

Electrical and General Engineers.

Steam Plough Works: LEEDS.

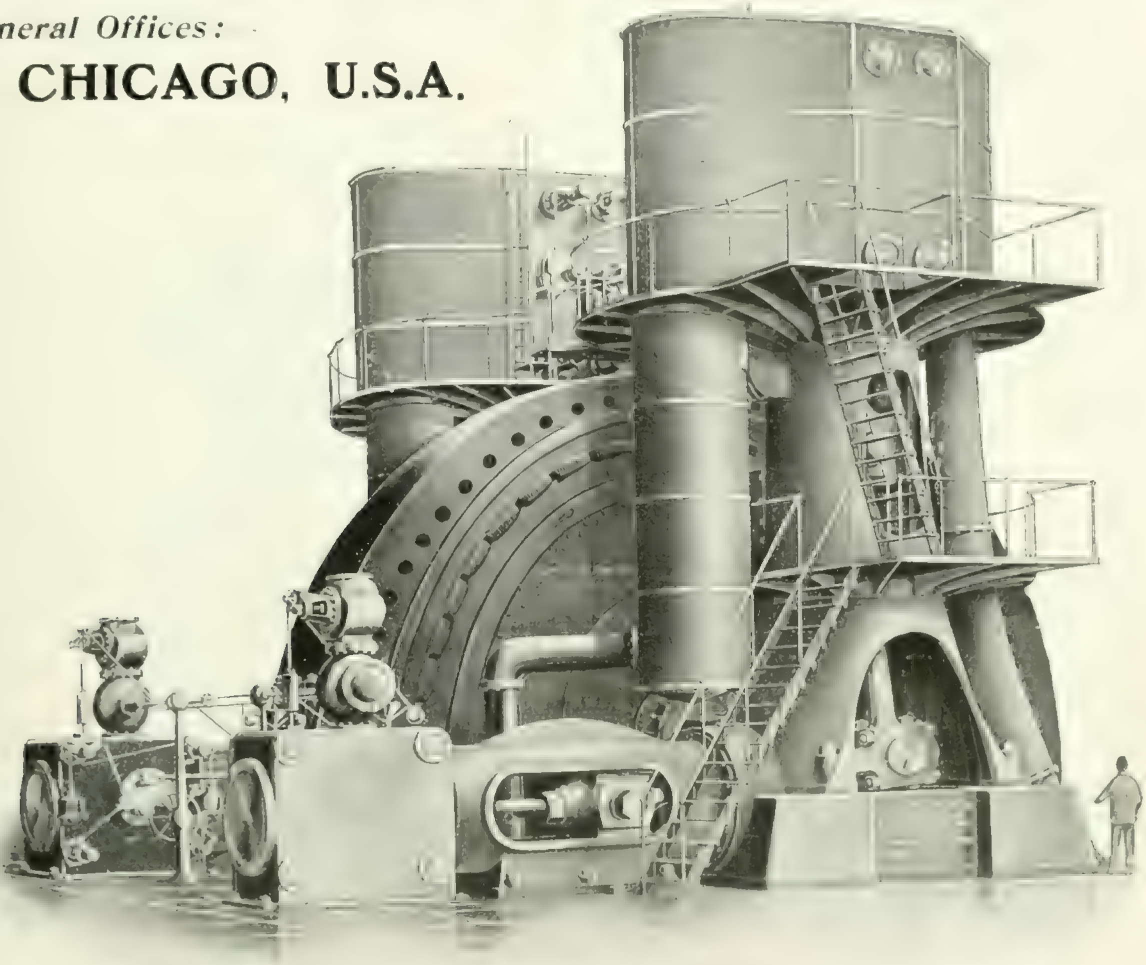


Fowler's Road Locomotive. Designed for all kinds of Steam Haulage, and is also available for temporary belt driving. Three sizes of this Engine are standardized, and employed approximately for 20, 30, and 40 ton loads. A special heavy Engine is also made equal to a load of 50 tons, and called the "Lion" type. The Engine was thus named by the War Office Authorities, who employed a number of them in the South African Campaign.

ALLIS-CHALMERS Co.

General Offices:

CHICAGO, U.S.A.



SOLE BUILDERS OF—

Reynolds' Engines for Power Plants, Rolling Mills, Blowing Engines, etc.

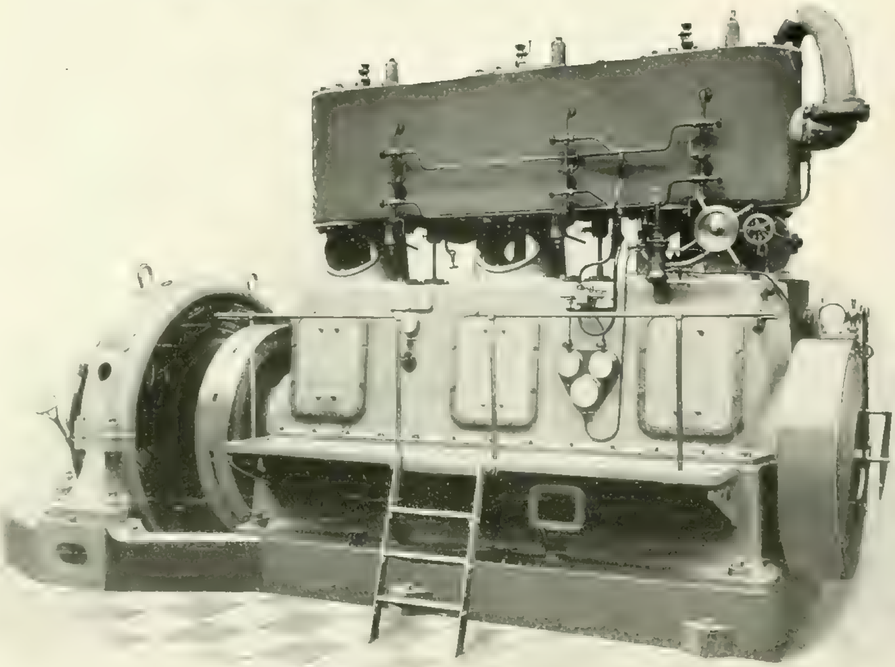
General European Headquarters:—

SALISBURY HOUSE, FINSBURY CIRCUS, LONDON, E.C.

[*WRITE FOR CATALOGUES.*

GALLOWAYS LTD.,

MANCHESTER.



High-Speed Engines. QUICK DELIVERY.

Compound and Triple Expansion.

SLOW-SPEED CORLISS ENGINES for Mill Work.

Galloway Boilers. IMMEDIATE DELIVERY.

All Sizes and all Pressures.

WROUGHT STEEL SUPERHEATERS. The Safest and Most Reliable on the Market.

Telegrams: GALLOWAY, MANCHESTER. London Office: 17, PHILPOT LANE, E.C.

A SPECIMEN LETTER FROM ONE OF OUR ADVERTISERS.

TRADE MARK REGISTERED

PAT AUG 7 1894

QUAKER CITY RUBBER Co.

SOLE MANUFACTURERS OF

PHILADELPHIA, PA. U.S.A.

DANIEL'S PATENTED P.P.P. ROD PACKING AND DANIEL'S EBONITE.

RESVALAR LONDON

RONALD TRIST & Co.

Managers for Great Britain.

ALL CHEQUES TO BE CROSSED PAYEES ONLY

Leadenhall House,
101, Leadenhall Street

LONDON, E.C. Oct. 1st 190

The Advertising Manager,
"Page's Magazine,"
Clun House,
Surrey Street, Strand, W.C.

Dear Sir,

It may interest you to know that, as a result of our half-page advertisement in the last three issues of "Page's Magazine," we have obtained very gratifying results.

We have received a number of inquiries from Engineers and Engineering firms, not previously on our books, and by closely following them up, we have in several cases done business. They are now permanent clients.

Whilst it is against our general policy to write letters of this nature, we feel so satisfied with the investment that we have pleasure in acquainting you with the fact that we are considering the advisability of increasing our space with you.

Yours faithfully,

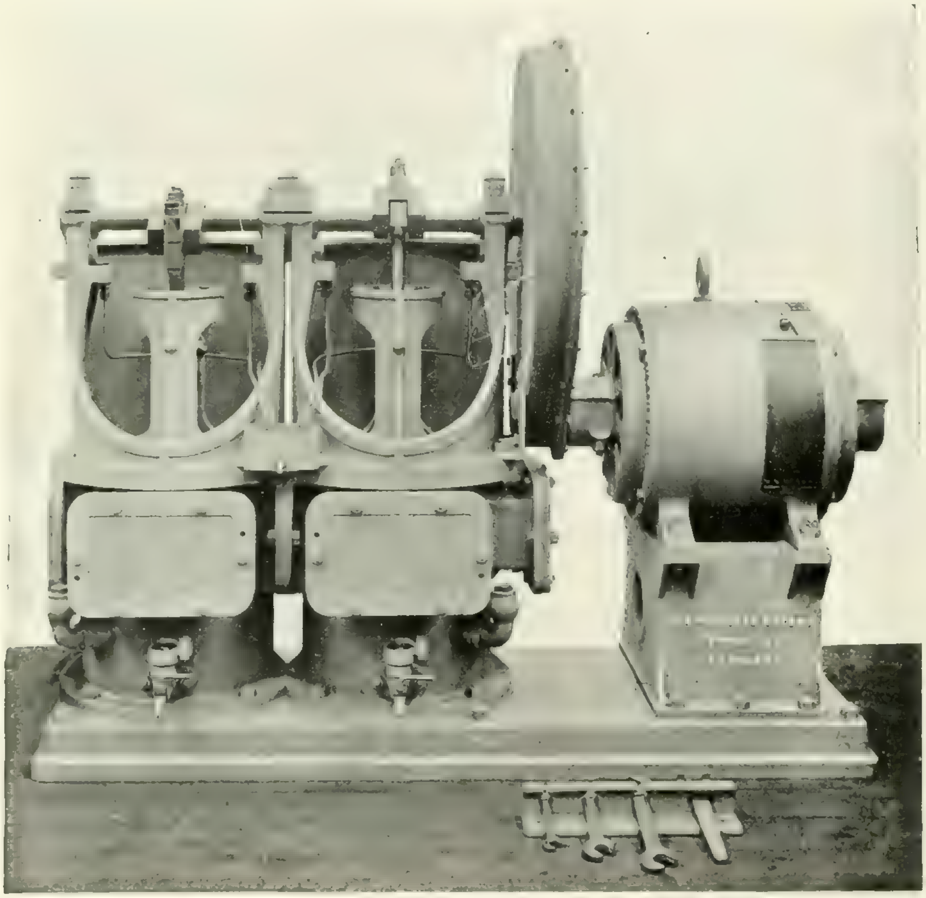
QUAKER CITY RUBBER Co

Ronald Trist & Co

Manager.

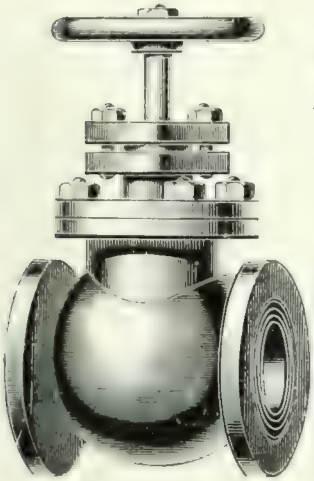
The Mirrlees-Watson Co., LIMITED,

GLASGOW, SCOTLAND.



CONDENSING PLANT FOR HIGH VACUUM.

LONDON OFFICE:
158, Gresham House,
Old Broad Street, E.C.



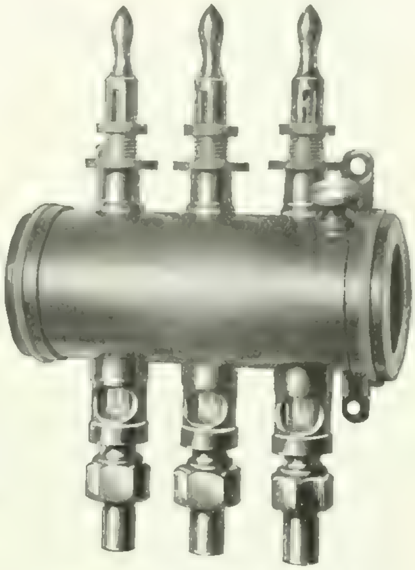
G. M. Flanged Wheel Valve
No. [illegible] B Type.

Hunt and Mitton,

MAKERS OF

HIGH-CLASS FITTINGS ONLY

for Engines and Boilers.



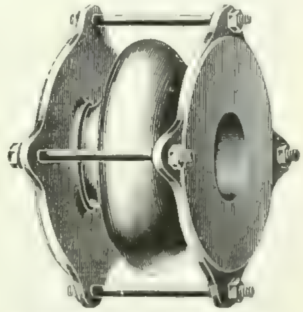
Patent "End Sight" Oil Distributing Box.
No. [illegible]

Engineers' Brass Finishers.

Mitton's Patent Centrifugal Crank Pin Oiler.
No. [illegible]

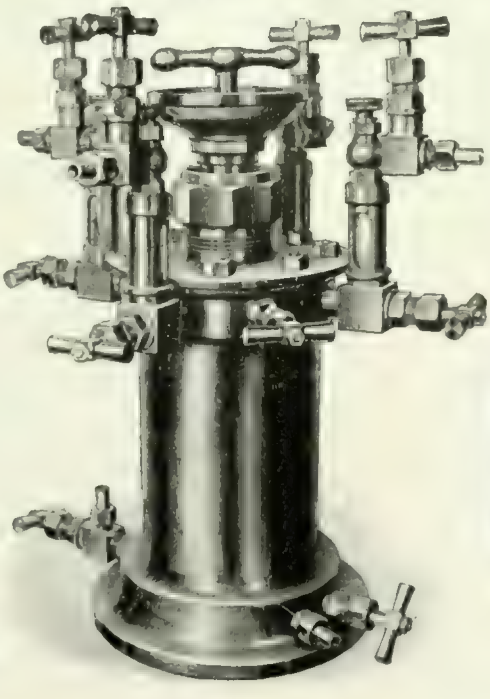
CROWN BRASS WORKS,
OOZELLS STREET NORTH,
BIRMINGHAM.

Telegrams:
"Mitton, Birmingham."
Telephone:
[illegible]

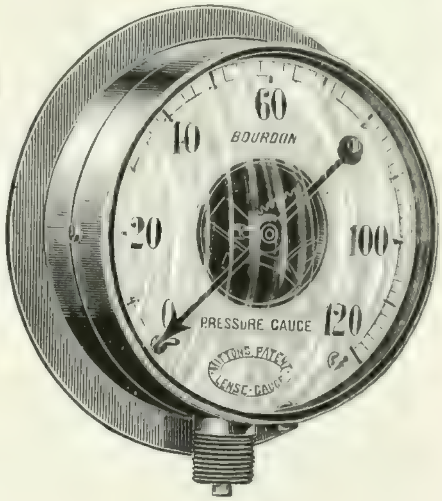


[illegible] Copper Expansion Box to take up Expansion of Pipes.

Oil Gauge Indicator for Solid Bearings.
No. [illegible]



Steam Cylinder Lubricators.
No. [illegible]



Mitton's Patent Lens Face Pressure Gauge.

5-ton ELECTRIC TRAVELLING CANTILEVER CRANE.
For Stocking and Loading Material. Span: 325 ft

MACHINERY FOR ECONOMIC HANDLING OF MATERIALS.

DESIGNED AND BUILT BY

The Brown Hoisting Company.

London Office—
39, VICTORIA ST., S.W.

Main Office and Works—
CLEVELAND, OHIO, U.S.A.

New York Office—
26, CORTLANDT STREET.

THE CLEVELAND BRIDGE & ENGINEERING Co.

LIMITED,
DARLINGTON, ENGLAND.

Bridge Builders & Contractors.

Annual output 15,000 *tons.*

CONTRACTORS FOR
The New High-Level Bridge over the Tyne at Newcastle for the North-Eastern Rly. Co., carrying four Railroads, value half a million.

SPECIALISTS IN DEEP FOUNDATION WORK.

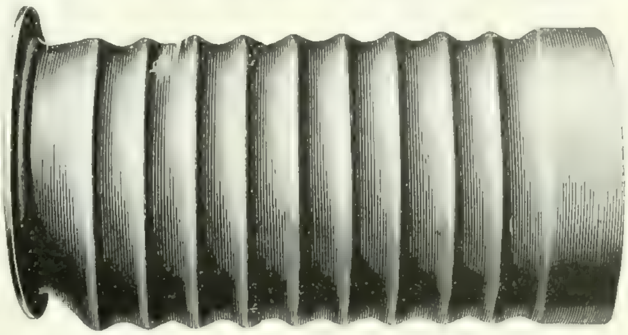
These Furnaces are Made from Special Quality of Open-Hearth Acid Steel Produced at Our Works, from the Best Selected Brands of Swedish and Cumberland Hematites.

MORISON SUSPENSION FURNACES

SUPPLIED TO CUNARD, WHITE STAR, AND ALL THE LEADING STEAMSHIP LINES IN THE WORLD.

EASILY SCALED.

MADE UNDER ALL SURVEYS.



GREATEST EVAPORATIVE EFFICIENCY

UNIFORM THICKNESS.

HIGHEST FACTOR OF SAFETY.

LATEST FORMULAE ON APPLICATION.

Flanged Complete by Hydraulic Machinery.

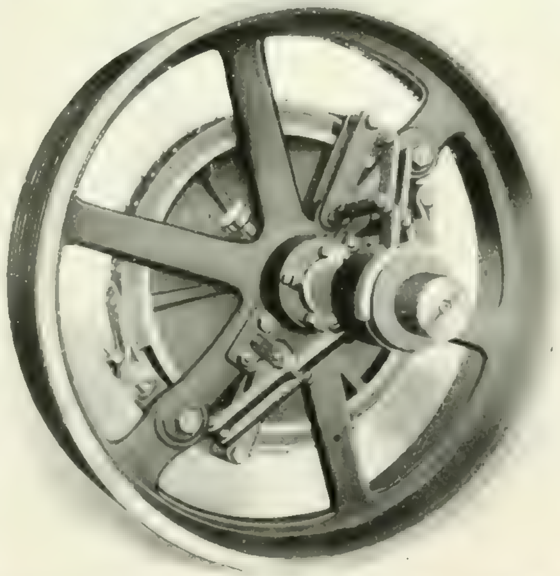
THE LEEDS FORGE COMPANY, LTD.,

LEEDS.

To main[illegible]

The United States [illegible] Morison [illegible] other Corrugated Types of [illegible]

Friction Couplings & Pulleys.



(KING'S PATENT.)

Made in 8 Sizes, from 5 to 1,000 H.P. for

GAS ENGINE & DYNAMO DRIVES.

HOISTING & WIRE DRAWING, &c.

Prices and Particulars on Application to:

H. J. H. KING & CO.,

Engineers: NAILSWORTH, Glos.

London Agency:
P. S. BURR,
85, Gracechurch St., E.C.

Agents for India:
D. FURDOONJI & BROS.,
Apollo St., Bombay.

GRAHAM, MORTON & CO., LTD., LEEDS.

PHOTOGRAPH SHOWING PORTION OF OUR NEW ENGINEERING WORKS, LEEDS.

Three bays, each 50 ft. span, 420 ft. long. Made and erected by ourselves.

Makers of Conveying Plants, Colliery Plants, Steel Structural, and Roofs complete.

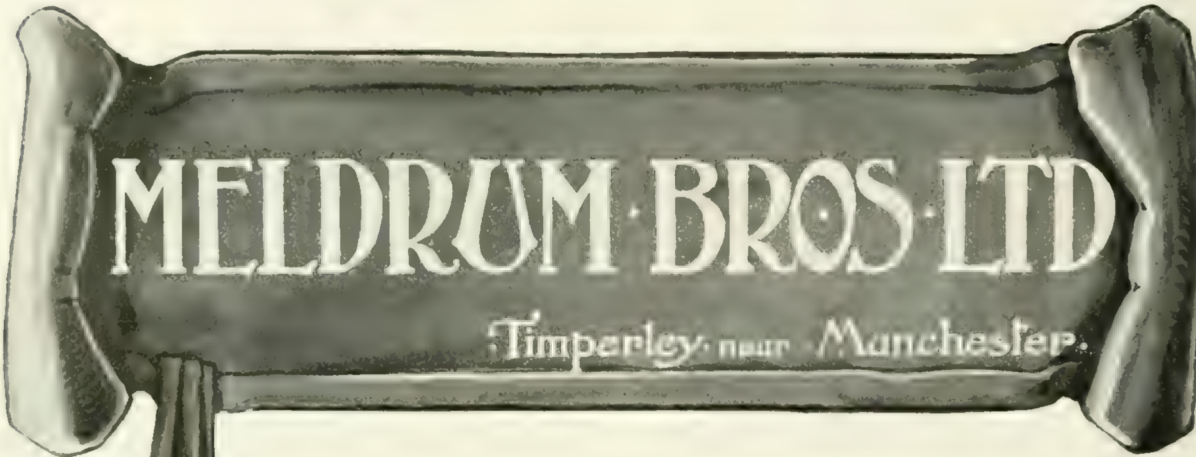
Send for Particulars.

PRODUCER GAS PLANTS

For Gas Engines.
For Furnaces.

Furnaces designed and built
for all purposes.

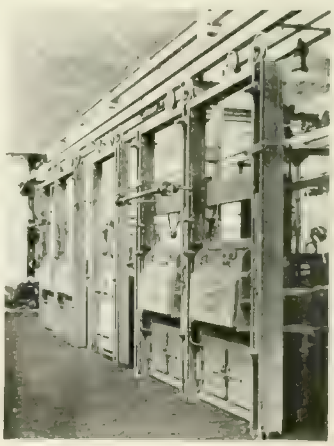
W. F. MASON, LIMITED,
Engineers & Contractors,
MANCHESTER.



The Meldrum Destructor effectually disposes of refuse once and for all. Not merely eliminating the undesirable, it conserves the valuable residue, and proves at once an indefatigable scavenger and money-maker. Wideawake corporations are now using the surplus heat for steam power in their electric light and tram departments, sewage pumping, and other municipal enterprises.

Engineers and others interested in the subject of Contemplated Destructor Installations, are invited to communicate with us.

This illustration shows half the plant destined for Johannesburg erected in our shop before being shipped.



TIMPERLEY, MANCHESTER,
AND
66, VICTORIA STREET,
WESTMINSTER,
LONDON.

THE

"HORSFALL" DESTRUCTOR

☛ Hot Blast.

Adopted at

Westminster,
Fulham,
Brussels,
Leeds,
Bradford,
Hull,
Sheffield,
Monaco,
&c., &c.

Adopted at

Oldham,
Finsbury,
Accrington,
Blackpool,
West Hartlepool,
Leamington,
Hamburg,
Windsor,
&c., &c.

Plants at work	**60**
Contracts in hand	**17**
New Orders since Jan. 1st, 1903 .	**16**

Including DURBAN, BLOEMFONTEIN, CAPETOWN (Hospital), FOLKESTONE, SWANSEA, &c., &c.

The Horsfall Destructor Co., Ltd.

Lord Street Works, LEEDS.

Telegrams: "DESTRUCTOR, LEEDS."
A B C, 5th Edition, and LIEBER'S CODES.

19, Old Queen Street,
Westminster, LONDON, S.W.

Telegrams: "DESTRUCTOR, LONDON."

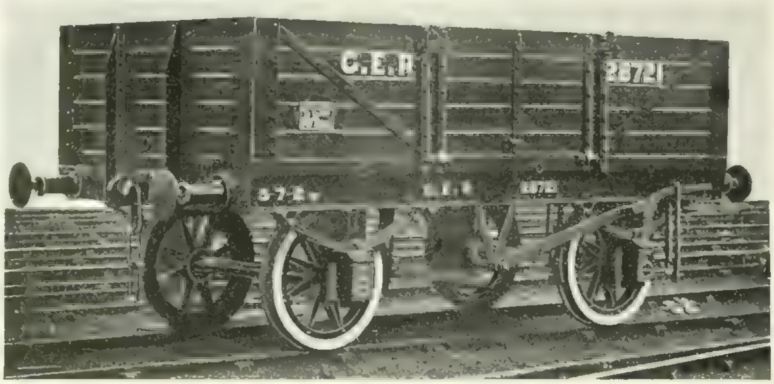
W. R. RENSHAW & CO., LIMITED.

MANUFACTURERS OF

Railway Wagons, Railway Carriages, Railway Ironwork.

Railway Wheels & Axles of every Kind.

SPECIAL ATTENTION GIVEN TO ROLLING STOCK FOR SHIPMENT.



One of 750 Steel Frame Goods Wagons built for Great Eastern Railway Company.

We have special modern plant for the quick production of . .

All-Steel High Capacity Wagons.

Telegrams:
"Renshaws, Stoke-on-Trent."
"Opificer, London."
Telephones:
58 Potteries.
16 Avenue, London.

Phœnix Works, STOKE-ON-TRENT.

London Office: 46, King William Street, E.C.

"VACUUM" WASTE OIL FILTERS (Patent).

SAVE INITIAL OUTLAY IN A SHORT TIME.

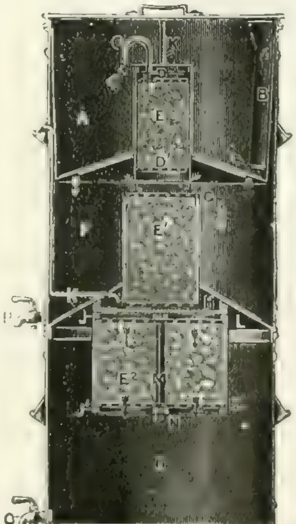
Prices from **37s. 6d.** to **£21** each, with filtering capacities varying from 2 gallons **per week** to 60 gallons **per day.** (In three types.) Largely adopted by gas engine and other machinery users. Invaluable for **Electric Lighting Stations.** Full particulars on application. Also of our

PATENT OIL STORAGE CABINETS.

Closed.

N.B.—Vacuum Oils after used do not lose their lubricating properties in filtering, as do other manufactures in this respect. The filter merely separates the dirt and other foreign matter which get into the oils **when on** the machinery.

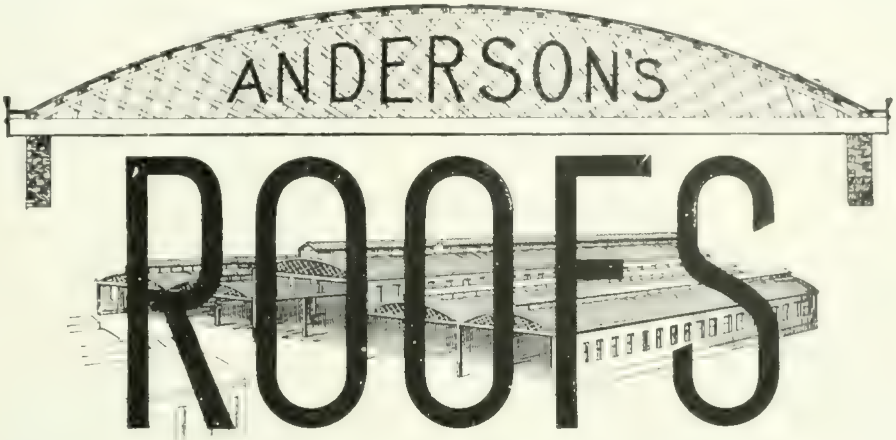
"B" TYPE PATENT FILTER.



VACUUM OILS are used and recommended by leading Engineering firms.
Special grade for Super-heated Steam.

Open.

VACUUM OIL COMPANY, L^TD., Norfolk Street, LONDON, W.C.



More durable than iron. Cheapest for all spans up to 100 Feet.

D. ANDERSON & SON, Ltd.,

LAGAN FELT WORKS, BELFAST, and
FINSBURY PAVEMENT HOUSE, LONDON, E.C.

The Portable Building Co., Ltd.

Finsbury Pavement House, LONDON.

FLEETWOOD.

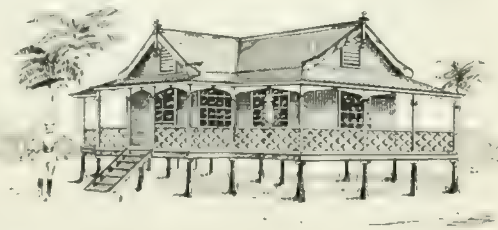
Manchester Chambers, MANCHESTER.

Buildings for Home and Export.

Military Quarters, Residences, Bungalows, & Hotel Buildings.

Portable, Artistic, and Comfortable Dwellings.

SPECIAL DESIGNS FOR ALL CLIMATES.

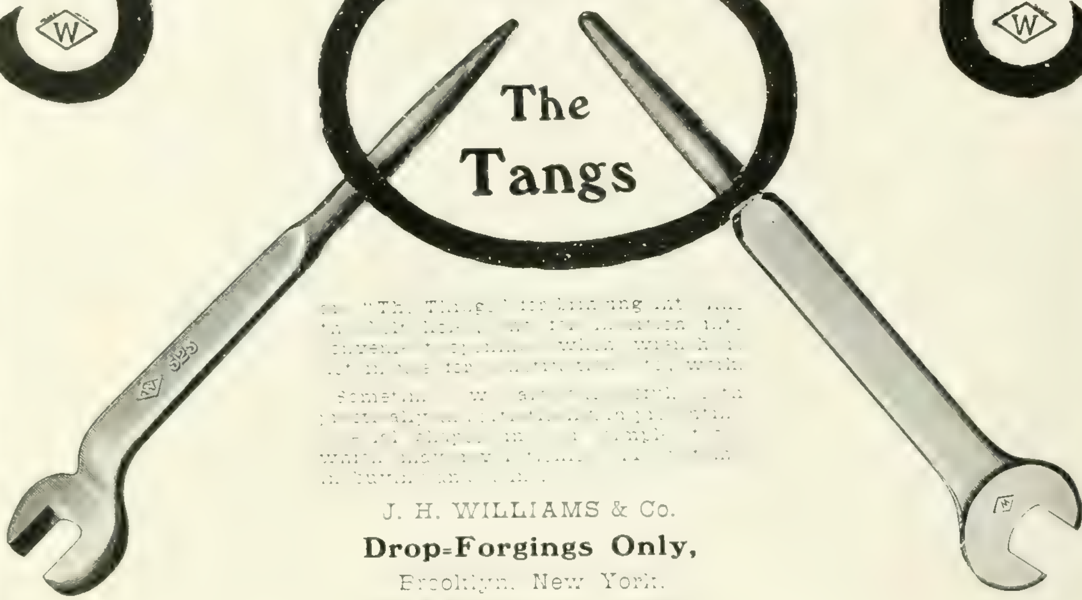


Buildings Packed & Marked in Sections for Easy Transport & Erection.

DELIVERED F.O.B. LIVERPOOL, LONDON, or SOUTHAMPTON.

Estimates, Designs & Catalogues Free.

South African Address:
P.O. BOX 175 JOHANNESBURG.



The Tangs

J. H. WILLIAMS & Co.

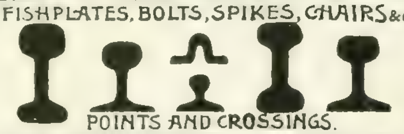
Drop=Forgings Only,

Brooklyn. New York.

Structural Construction.

RAILS

FISHPLATES, BOLTS, SPIKES, CHAIRS &c.



POINTS AND CROSSINGS.

WILLIAM FIRTH L^TD^ LEEDS

STEEL & MALLEABLE IRON CASTINGS FOR ENGINEERS & TOOL MAKERS TO MACHINE CLEAN & BRIGHT ALL OVER.

PARKER FOUNDRY CO, DERBY.

ON ADMIRALTY LIST.

J. Fredk. Melling,

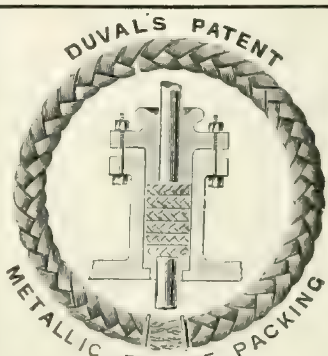
14, PARK ROW,
LEEDS, ENGLAND.

Iron & Steel Bars, Plates, Sheets, Girders, Channels, Angles, Rails, Blooms, Billets, & Slabs.

Write for Section Lists and Prices

A PURE METALLIC PACKING.

Lasts for many years, and keeps the Rods in perfect condition.



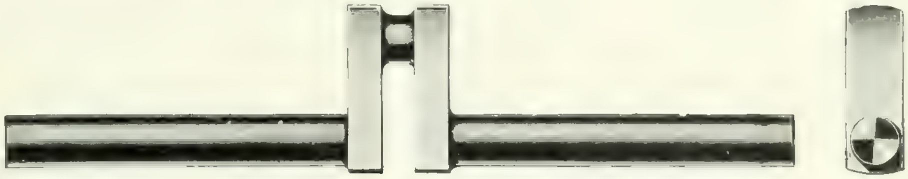
Used same way as ordinary soft. For all classes of Engines and Superheated Steam.

J. BENNETT VON DER HEYDE, 6, Brown St., MANCHESTER.

ON ADMIRALTY LIST

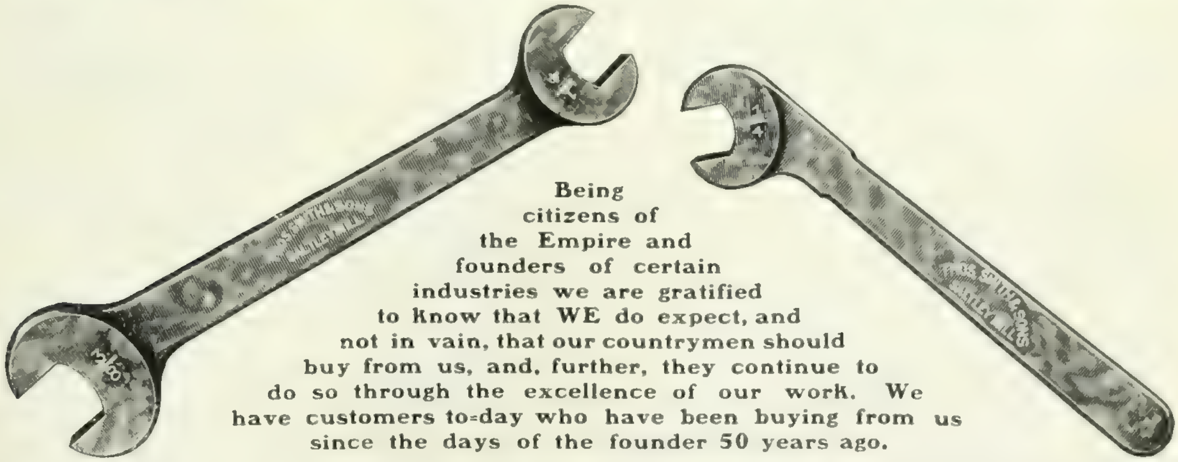
Telegrams: "CRANKS, LINCOLN."

FOR CRANKS & FORGINGS OF EVERY DESCRIPTION WRITE TO



CLARKE'S CRANK & FORGE CO., LTD., LINCOLN, ENGLAND.

Support Home Industries.

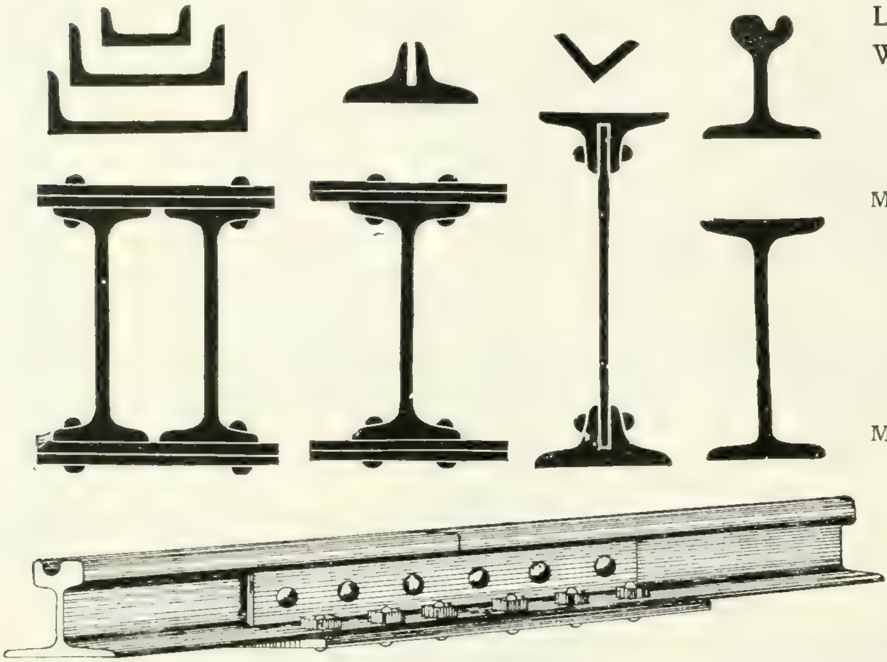


Being citizens of the Empire and founders of certain industries we are gratified to know that WE do expect, and not in vain, that our countrymen should buy from us, and, further, they continue to do so through the excellence of our work. We have customers to-day who have been buying from us since the days of the founder 50 years ago.

THOMAS SMITH & SONS, OF SALTLEY, LIMITED, BIRMINGHAM.

ESTABLISHED 1848.

WALTER SCOTT, Ltd.,



LEEDS STEEL WORKS . . .

Telegrams: "BESSEMER, LEEDS."

LEEDS, ENGLAND.

Manufacturers of . .

Rolled Steel Joists, Channels, etc.

Mild Steel Blooms, Billets, Slabs, Tinbars, Rounds, and Flats.

Speciality:

Tramrails.

Books of Sections and other information on application.

F. A. KEEP, JUXON & Co.

RIVETTED WORK

OF EVERY DESCRIPTION.

TANKS FOR TRANSPORT SERVICE.

MISCELLANEOUS IRON-PLATE and CONSTRUCTIONAL IRONWORK.

Forward Works,
BARN STREET,
BIRMINGHAM.

National Telephone 877
Telegrams: "Structures, Birmingham."

Styrian Steel Works, SHEFFIELD.

SAM^L. BUCKLEY,

St. Paul's Square, BIRMINGHAM.

MANUFACTURER, ROLLER & FORGEMAN of every description of

CRUCIBLE CAST & MILD STEELS.

Speciality:

BOHLER STYRIAN STEEL.

Contractor to H.M. Government, War Office, Admiralty, India Office, & Foreign Govts.

EDGAR ALLEN & CO., LTD.

TOOL STEEL, SAW & FILE MANUFACTURERS, & STEEL FOUNDERS.

SOLE MAKERS OF . .

THE EDGAR ALLEN

AIR-HARDENING

TRADE MARK GRANTED 1885

HIGH-SPEED TOOL STEEL AND TWIST DRILLS.

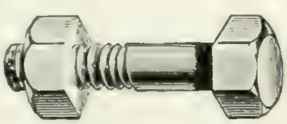
Allen's IMPERIAL Manganese Steel

CASTINGS & **BARS** for TRAMWAY POINTS & CROSSINGS, DREDGER PINS & BUSHES, ORE CRUSHERS, &c.

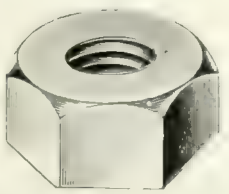
CORRESPONDENCE INVITED.

IMPERIAL STEEL WORKS, TINSLEY, SHEFFIELD.

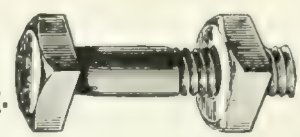
RICHARD DAVIES & SONS.



VICTORIA BOLT AND NUT WORKS,



BILBERRY ST., MANCHESTER.



Manufacturers of BOLTS, NUTS, WASHERS, RIVETS, TIE-RODS IN IRON OR STEEL. Also BEST BRIGHT FINISHED NUTS SET SCREWS, WASHERS, &c., FOR ENGINEERS AND MACHINISTS. Telegrams: "HEXAGON, Manchester."

CONSETT IRON COMPANY L[D]

WORKS AND OFFICES - CONSETT C DURHAM

Steel Plates & Angles

(Siemens Acid Process).

Tees, Bulbs, Zeds, Channels, Bulb Tees, and Angles,

ROUND, SQUARE AND FLAT BARS.

STEEL CHEQUER PLATES

BESSEMER PIG IRON. *Oval and Diamond Patterns.*

WEEKLY OUTPUT:

Steel Plates - - -	**2,500**	Tons.
,, Angles - - -	**1,500**	,,

CONSETT

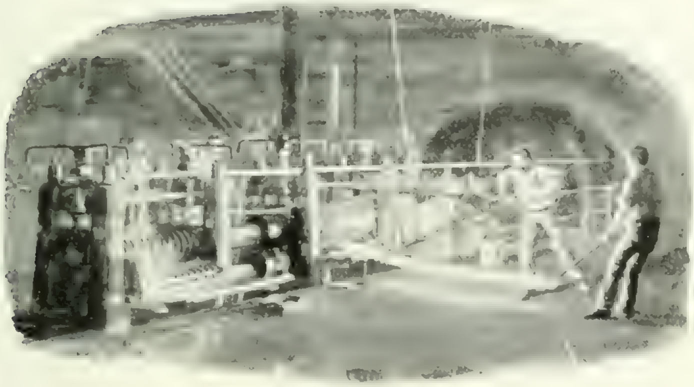
COAL OWNERS and MAKERS of

Firebricks, Coke, &c., for Blast Furnaces and Foundries.

Material of the HIGHEST QUALITY manufactured, such as is used by the British and Foreign Governments for Shipbuilding and Engineering purposes.

OFFICES CONSETT DURHAM AND NEWCASTLE ON TYNE

Farnley Iron



ROLLING BARS.

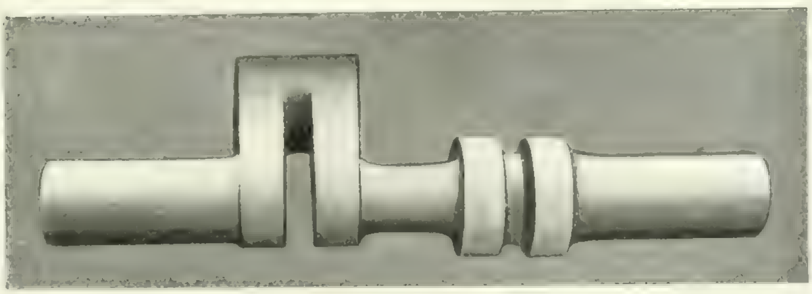
Farnley **Bar Iron** is used in **Mining** for pit cages, suspending gear, and other important parts, and on all the leading **Railways** in Great Britain, India, and the Colonies, for shackles and other vital parts subjected to repeated shocks.

Farnley Iron will stretch cold from **1$\frac{1}{8}$** in. to **2$\frac{1}{8}$** in. in a length of **6** in. before fracture, and is safest for **welding**.

Address: The Farnley Iron Co., Ltd., Leeds, England.

Crankshafts & Forgings

(ON ADMIRALTY, WAR OFFICE, &c., LISTS.)



BENT CRANKS (Square or Round) FOR MARINE AND OTHER PURPOSES.

WOODHOUSE & RIXSON,

. . . SHEFFIELD.

Telegrams: "FILATURE."
Telephone: 202, 228.

The St. Helens Cable Co.

LIMITED.

WARRINGTON.

Our Speciality, DIALITE.

A really waterproof cable.

Cheap, light and flexible.

No danger of corrosion.

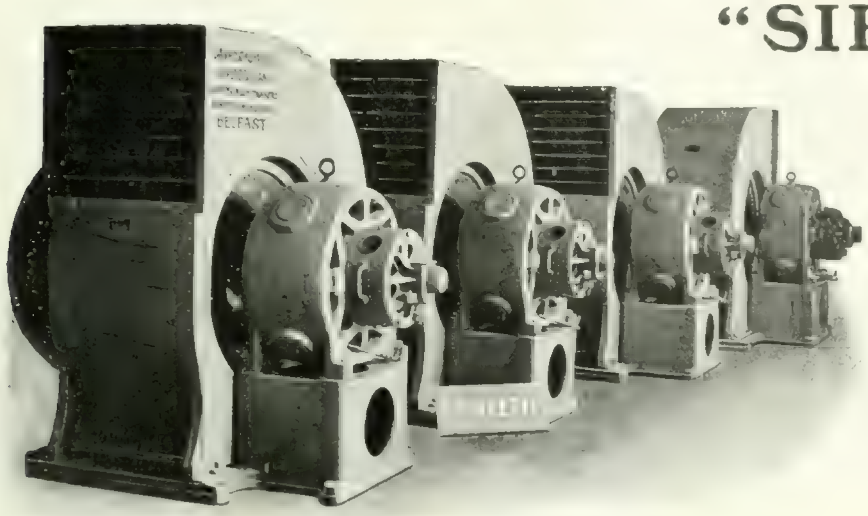
We are also Manufacturers of

Vulcanized Rubber, paper, lead covered, and dry core cables.

Flexible and cotton covered conductors, and all kinds of mechanical rubber goods, Tapes, &c.

London Office: 32, VICTORIA STREET, WESTMINSTER.

Telegrams: "FILATTERIO."
Telephone: 4270 GERRARD.



"SIROCCO" FANS FOR S.S. "CELTIC"

"SIROCCO"
Centrifugal Fans

. . FOR .

VENTILATION
FORCED DRAUGHT
INDUCED DRAUGHT
HEATING,
COOLING,
DRYING,
REFRIGERATION,
DUST REMOVAL,
FORGE FIRES, Etc. Etc.

Also "Sirocco" Propeller Fans, Furnace Fronts, Engines, etc.

DAVIDSON & CO., Ltd., Illustrated and Descriptive Pamphlets on Application

Branches: LONDON, MANCHESTER, GLASGOW. Also foreign branches.

"Sirocco" Engineering Works, BELFAST.

SÜDDEUTSCHE KABELWERKE A.-G., Mannheim, GERMANY.

(SYSTEM BERTHOUD BOREL.)

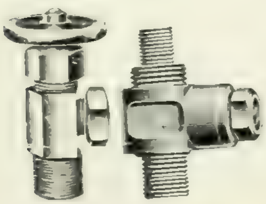
Contractors to the Imperial German Postal Authorities.

TELEPHONE CABLES

With Paper and Air Insulation.

LEAD-COVERED CABLES
For all Tensions up to 40,000 volts.

SILK-COVERED COPPER WIRES.



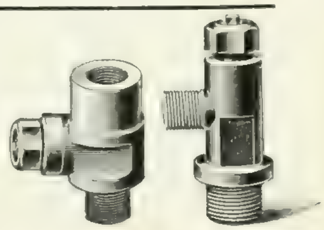
The

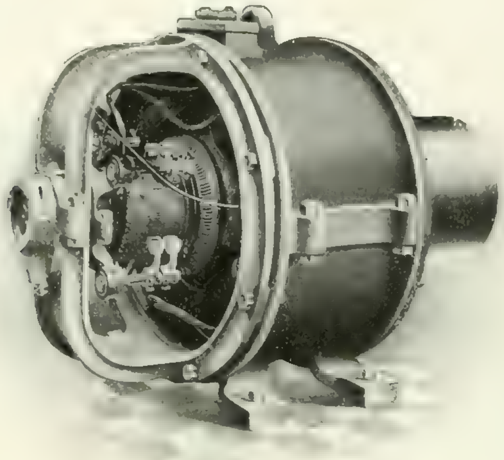
Scotch & Irish Oxygen Co., Ltd.,

ROSEHILL WORKS, GLASGOW.

Valves for Gas Bottles, Refrigerating Plant, etc., in Bronze, Steel, and Aluminium.

Reducing Valves, Keys, and all Fittings for Compressed Gases.





MOTORS,

Open, Protected,
Enclosed.

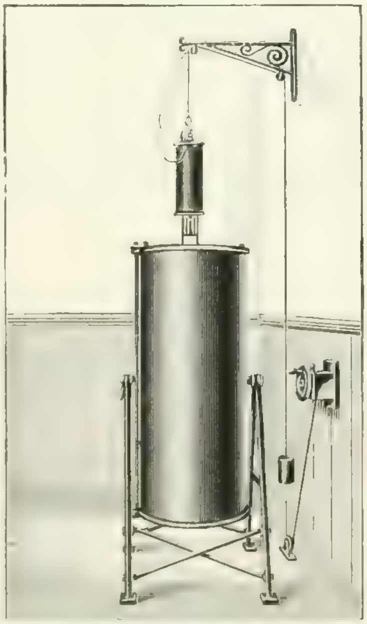
BELT DRIVE OR
BACK GEAR.

MATHER & PLATT, Ltd.,

SALFORD IRON WORKS,

MANCHESTER.

J. HALDEN & Co., 8, ALBERT SQUARE, MANCHESTER.



Copies Two Tracings at One Operation.

Arc Lamp Duplex Radial

PHOTO COPYING FRAME

(SHAW AND HALDEN PATENT).

Engineer's Electric Frame, very superior, Arc Lamp and Lowering Gear, Printing from Two Tracings 53″ x 31″, at one operation.. £42 10 0

Other sizes as per List post free on request.

ADVANTAGES OF DUPLEX RADIAL PHOTO-COPYING FRAME.

A. Copying indoors at any time where Electric Current is available.
B.- The Frame when once mounted on the Pedestal remains there.
C.—Immunity from accident ensured by the Frame remaining on the Pedestal.
D. The horizontal position (when placing in or taking out Tracings and Copies) is the most convenient for Operators.
E.—Two full-size Tracings can be copied at one operation.
F.—The glass plates can be very easily cleaned when Frame is horizontal.

Also at London, Newcastle-on-Tyne, Birmingham and Glasgow.

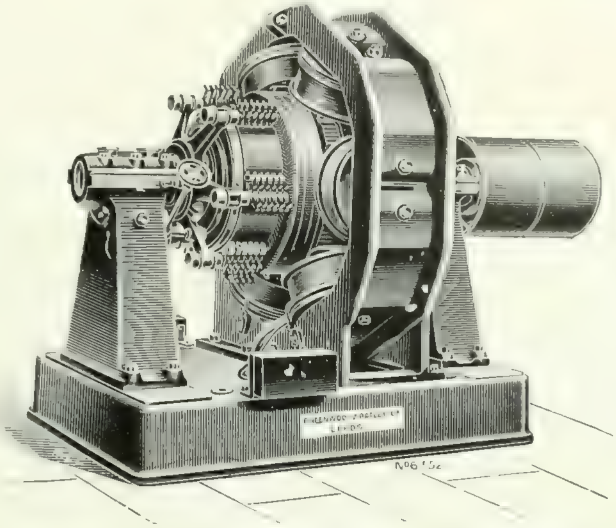
SOLE AGENTS in South Africa: EIDELBERG BROS. & CO., Pretorius St., Pretoria.
P.O. Box 232. Telegrams: "IBIS."

GREENWOOD & BATLEY, Ltd., ALBION WORKS, LEEDS.

MAKERS OF EVERY DESCRIPTION OF

ENGINEERS' GENERAL TOOLS and of SPECIAL TOOLS for War Material and a Great Variety of Purposes.

De Laval Patent
Steam Turbine
Dynamos,
Turbine Motors,
Pumps and Fans.



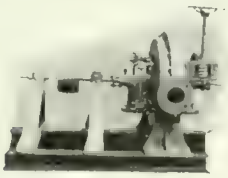
Dynamos and
Motors,
Complete
Electrical
Installations.

No. 6352. 200 B.H.P. Electric Motor, 420 volts, 400 revolutions.

FOR ANY SIZE OR TYPE OF

TURBINE

OR PELTON WHEEL

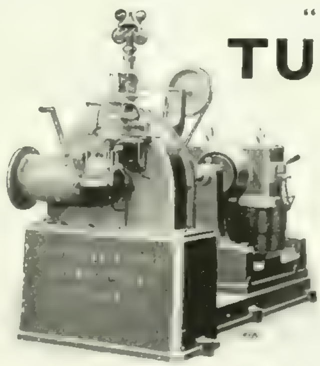


Apply to: -

G. GILKES & CO., LTD.
KENDAL.

"GUNTHER"

TURBINES



WITH VERTICAL OR HORIZONTAL SHAFTS.
SPECIAL
HIGH PRESSURE TURBINES & ACCURATE HYDRAULIC GOVERNORS for Electric Plants.
PELTON WHEELS.

W. Gunther & Sons,
Central Works,
OLDHAM. ENGLAND.

TURNER DIRECT-CURRENT MULTIPOLAR MOTORS.

In 3 Types, **DP** (Dust Proof)

MP (Protected)

OP (Open)

HIGH-CLASS
Design
Workmanship
Material.

½ to 50 B.H.P.

Send for Revised and Reduced Prices to **TURNER, ATHERTON & CO., Ltd., DENTON, MANCHESTER.**

Allgemeine Elektricitäts-Gesellschaft, Berlin.

Capital fully paid up: 60 000 000 Marks.

Machine Works ∘ Electrical Apparatus-Works ∘ Cable Works
Incandescent-Lamp-Works.

Armoured Lead Cables for Potentials up to 20 000 Volts.
Bare and Insulated Wires.
Insulation-Materials: Rubber, Mica ,Micanite, Stabilit, Vulcan-Asbestos.

Continuous Current. Threephase Current.

Electric Lighting Plants. ◆ Electric Transmission of Power.
Electric Railways and Tramways. ◆ Electric Central-Stations.
Electrochemical Plants.

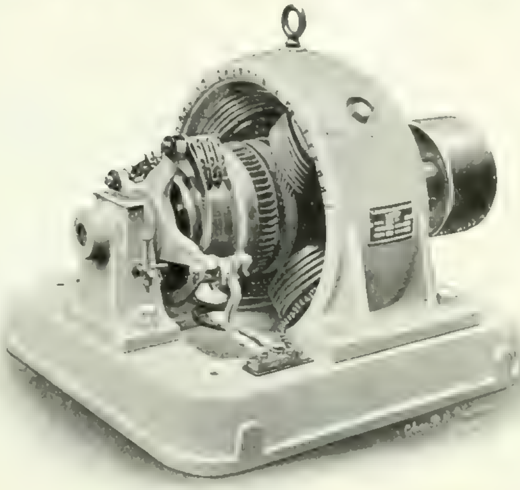
Agencies throughout the World.

Yearly Output 12000 Dynamos and Motors equivalent to 170 000 000 Watt
10 000 000 Incandescent Lamps. XI. 15.

T. HARDING CHURTON & CO.,

DIRECT
CURRENT
and
POLYPHASE.

Either Open or
Enclosed.



R.M. Type Generator.

ATLAS WORKS
Ingram St.,
LEEDS.

Ask for New
Price Lists.

GENERATORS & MOTORS.

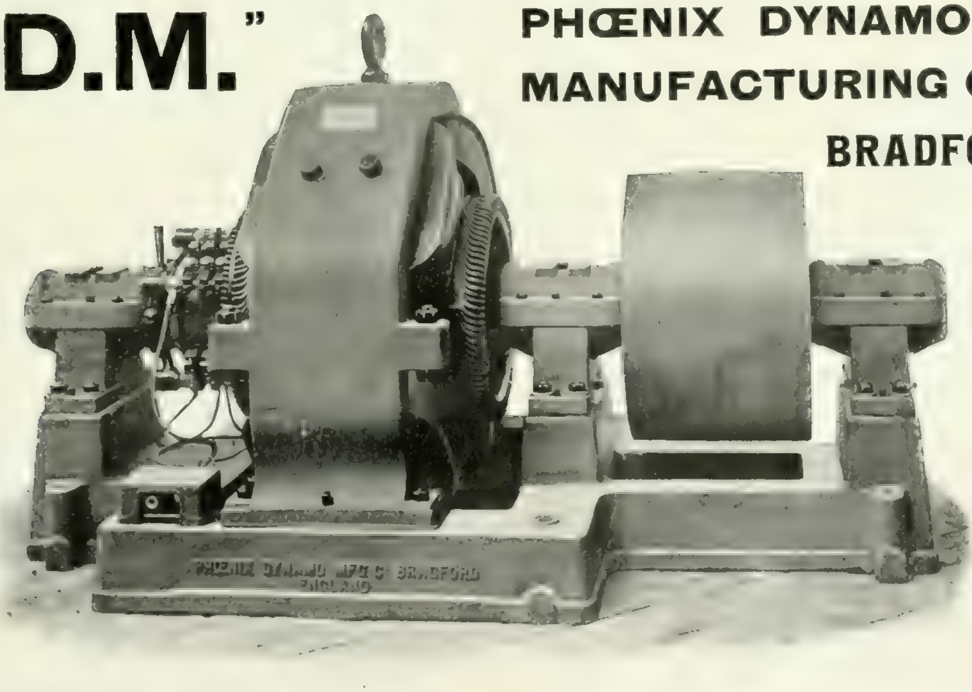
Telegrams:
"MAGNET, LEEDS."

Direct-Coupled Generators.

Telephone:
933 CENTRAL.

"P.D.M."

**PHŒNIX DYNAMO
MANUFACTURING CO.,
BRADFORD.**



50 Kilowatt Three Bearing Generator, 500 revs.

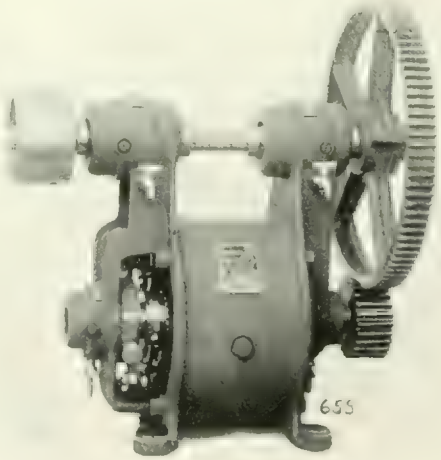
CROMPTON & COMPANY, LTD.

ELECTRICAL ENGINEERS,

CHELMSFORD & LONDON.

TELEGRAMS:
"CROMPTON CHELMSFORD.
CROMPTON, LONDON."

TELEPHONE:
CHELMSFORD No. 2.
1959 LONDON WALL (NATIONAL).
4735 CENTRAL (POST OFFICE).



TYPE OF CROMPTON GEARED MOTOR.

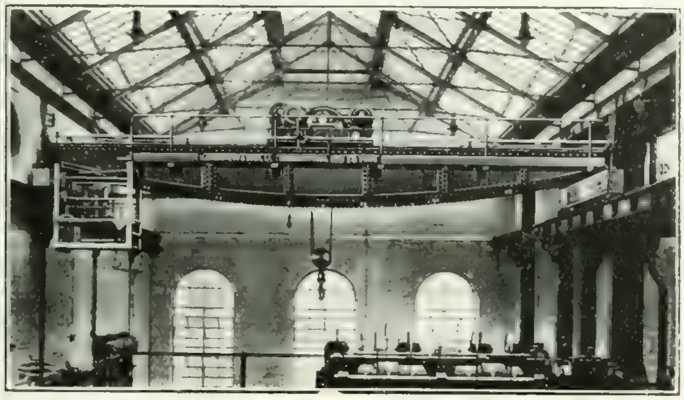
NUMEROUS DESIGNS FOR SPECIAL REQUIREMENTS.

FACTORIES AND ENGINEERING WORKSHOPS
ELECTRICALLY EQUIPPED THROUGHOUT.

DESIGNS AND ESTIMATES FREE.

CHIEF OFFICE: SALISBURY HOUSE, LONDON WALL, LONDON E.C.

ELECTRIC CRANES.



UP TO

100 TONS

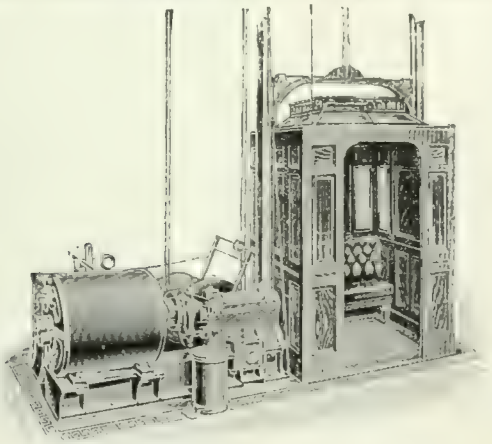
CAPACITY.

SEND FOR OUR NEW CATALOGUE.

THOMAS BROADBENT & SONS,
LIMITED,
HUDDERSFIELD.

WAYGOOD LIFTS.

By Special Appointment to H.M. the King.



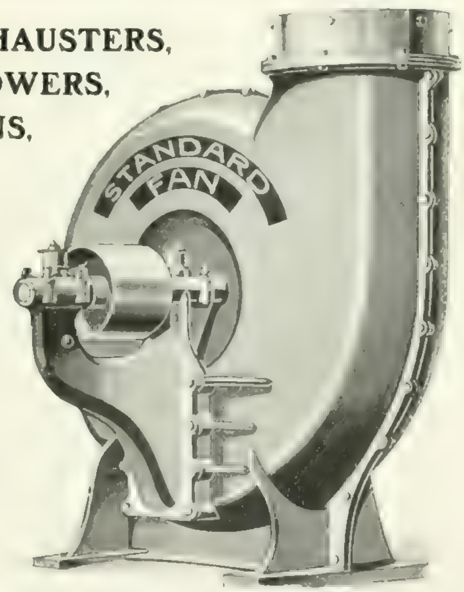
Electric, Hydraulic, Belt Driven, Hand

LIFTS & CRANES.

FALMOUTH RD., LONDON, S.E.

"STANDARD"

EXHAUSTERS,
BLOWERS,
FANS,
etc.

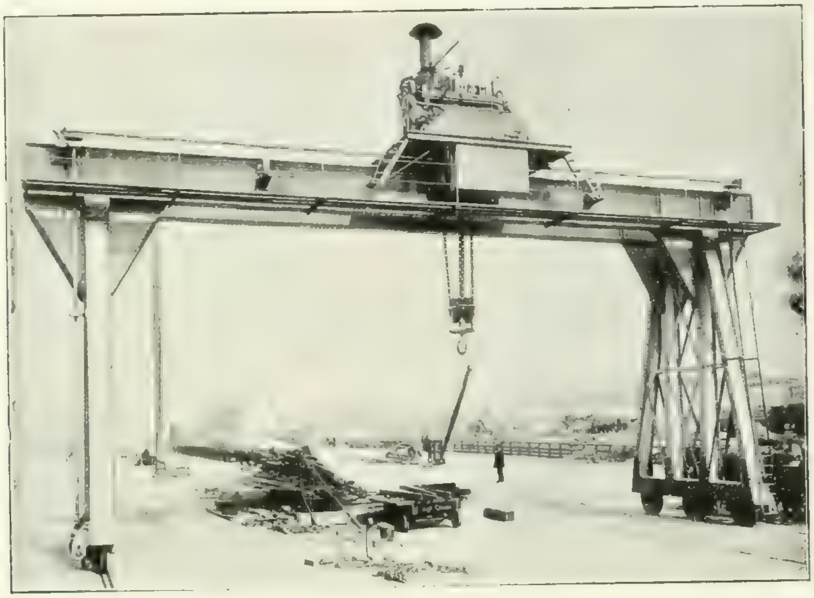


Write for Prices and Particulars to

THE STANDARD ENGINEERING CO., LTD.,
LEICESTER.

JOSEPH BOOTH & BROS.

LTD.,



40-ton Steam Goliath Crane at the new L. & N. W. Railway Goods Yard, Sheffield.
And also supplied to Midland, Lancashire & Yorkshire, and Great Western Rys., &c.

RODLEY,

LEEDS.

For

Lifting

Machinery,

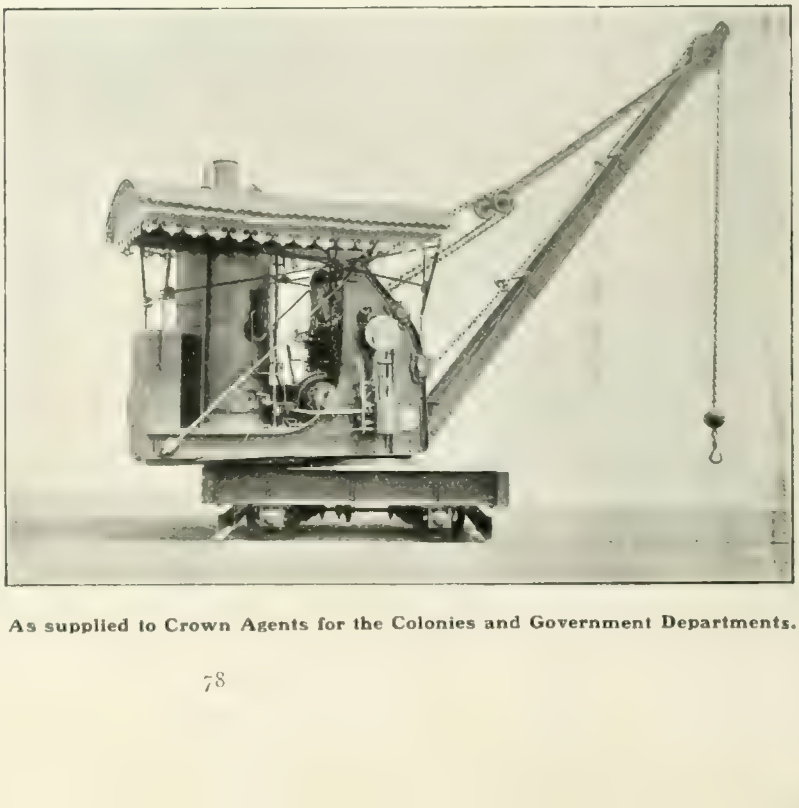
&c.

Cranes, Winding Engines, Overhead Travellers of Every Description, Driven by Steam, Electricity, or Hydraulic Power.

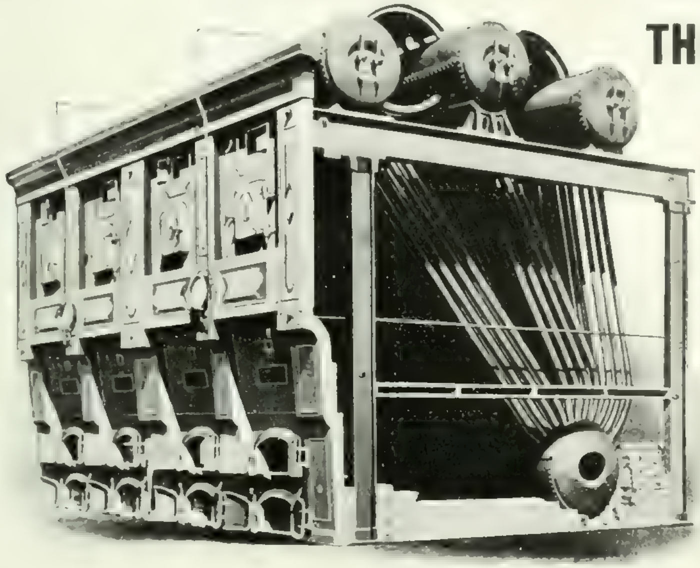
London Agents:
A. E. W. GWYN, Ltd.,
75a, Queen Victoria St., E.C.

Telephone:
20 STANNINGLEY.

Telegrams:
"CRANES, RODLEY."
"ASUNDER, LONDON"



As supplied to Crown Agents for the Colonies and Government Departments.



THE STIRLING COMPANY OF U.S.A.

The Original Manufacturers of the

STIRLING WATER-TUBE SAFETY BOILER

THE MOST ECONOMICAL BOILER ON THE MARKET.

ADAPTED for ANY KIND of FUEL, and for either HAND or MECHANICAL STOKING.

Specially suitable for Firing by Gas from Blast Furnaces or Producers, or for utilising Waste Heat from Heating Furnaces. Upwards of 1,500,000 H.P. of our Boilers in operation.

ESTIMATES GIVEN FOR COMPLETE BOILER-HOUSE EQUIPMENTS.

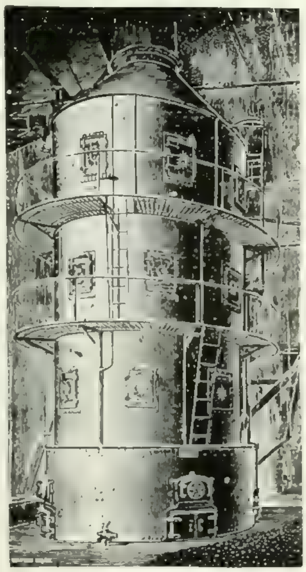
BRITISH BRANCH—

53, Deansgate Arcade, Manchester.

TELEPHONE 3098. Telegrams: "TUBULOUS, MANCHESTER."

THE MORRIN PATENT

'CLIMAX' WATER TUBE BOILER



600,000 H.P. in use.

Made in all sizes up to 1,500 H.P.

Suitable for all Steam raising purposes, and all conditions of working.

Best disposed Heating Surface for utilisation of furnace gases.

Best water circulating system and steam superheating system obtainable.

Tubes all one size, and expanded into one drum only.

Economical in floor space.

Economical in working, whether fired by hand or mechanically.

Also Coal, Coke, and Ash Conveying Plants, Water Softeners, and Purifiers, Steel Chimneys, &c.

B. R. ROWLAND & Co., LTD.,

Climax Boiler Works,

REDDISH, near MANCHESTER

London Office: 47, VICTORIA ST., WESTMINSTER.

LEEDS CITY BOILER WORKS

(Established 1862.)

ON ADMIRALTY LIST.

MAKERS OF **High-Class BOILERS**

To stand any test or pass any inspection.

MADE BY THE *LATEST IMPROVED MACHINERY.*

Most Modern and Complete Plant in Yorkshire.

VERTICAL BOILERS

Always in Stock and in Progress.

SPECIALITY. Boilers fitted with Deighton's Patent Corrugated Flues give 20 per cent increased heating surface over ordinary flues.

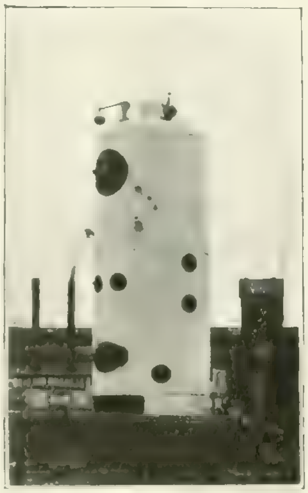
Contractors for Roofs and all kinds of Structural Iron and Steel Work.

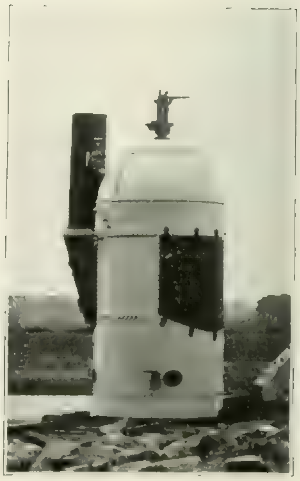
COCHRAN BOILERS

PATENT VERTICAL MULTITUBULAR

AND

High-Class Cross Tube





WRITE FOR CLASS A

CATALOGUE

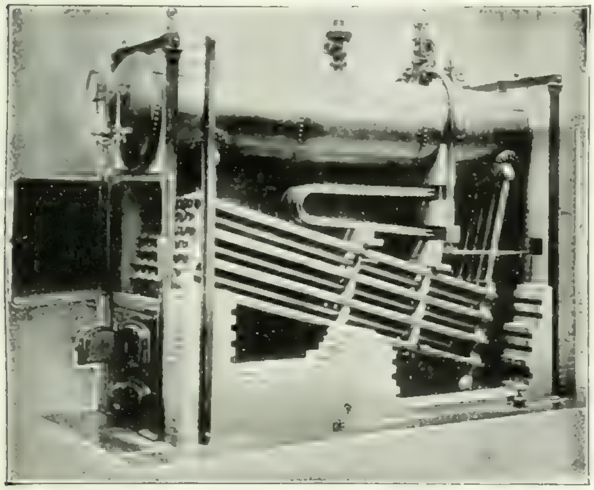
COCHRAN & CO. (Annan),

LIMITED,

ANNAN, SCOTLAND.

BABCOCK & WILCOX Ltd., Engineers and Manufacturers of

Patent Water=Tube Steam Boilers.



BABCOCK & WILCOX BOILER FITTED WITH SUPERHEATER

OVER 4,000,000 H.P. IN USE IN ALL INDUSTRIES.

The only Water Tube Boiler which gained the **GRAND PRIX** (Highest Award) at the Paris International Exhibition, 1900.

Complete Installations of Steam Piping and Boiler House Plants.

ALSO

WATER-TUBE MARINE BOILERS.

ESTIMATES AND PLANS ON APPLICATION

Head Offices—

LONDON: Oriel House, Farringdon St., E.C.; and Branches.

A valuable treatise on "Steam" and "Accessories" Catalogue free on application, to Engineers and Steam Users.

WORKS: RENFREW, SCOTLAND.

HERBERT W PERIAM L^TD.

FLOODGATE S^T WORKS BIRMINGHAM.

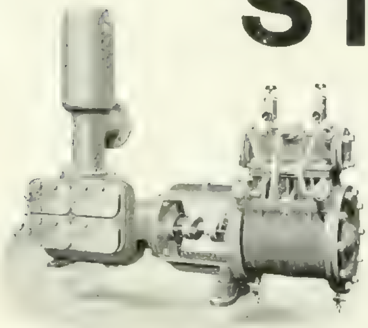
TELEGRAPHIC ADDRESS "FLOODGATE" BIRMINGHAM.

TELEPHONE Nº 373.

STOCK 250,000. GROSS

TANGYES

STEAM PUMPS



14 · 8 · 12 in. "Special" Pump.

FOR ALL DUTIES.

"SPECIAL" DUPLEX
FLY-WHEEL, &c.,

ALSO . .

Centrifugal Pumps, Treble-Ram Pumps, etc.

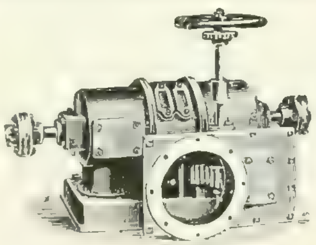
Electrically Driven Pumps

A SPECIALTY.

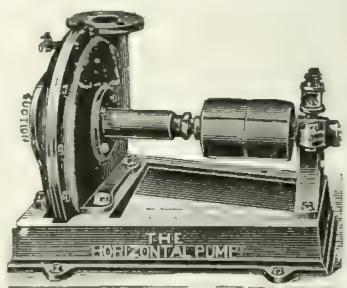
TANGYES LIMITED

CORNWALL WORKS,
Birmingham.

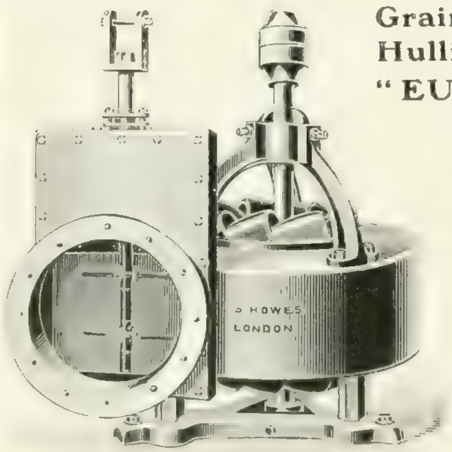
BRANCHES AT
London, Newcastle, Manchester, Glasgow, Cardiff, Rotterdam, Bilbao, Johannesburg.



S. HOWES Co.



SOLE MANUFACTURERS OF FLOUR, COFFEE, AND RICE MILL MACHINERY.



Grain and Seed Cleaning,
Hulling, Grading, and Polishing Machinery.
"EUREKA" Corn (Maize) Mill Machinery,
Degerminators, &c.
Flour, Bran, and Cement Packers.
Howes Grinding Mills.
Grain Scales. Dust Collectors.
Little Giant Turbines, Water Wheels,
Water Motors, and Pelton Wheels.

Head Office and Showrooms

64, MARK LANE, LONDON, ENGLAND.

Contractors to His Majesty's Government, Russian, French, &c.


PUMPS
LIGHT ON AN OLD SUBJECT
WE MAKE
PUMPS
Of every description and size, for all duties and services.
If you need one, or think you do, send to us for our new catalogue, just published, which we will forward you free of charge.
The . .
Blake & Knowles Steam Pump Works,
179, Queen Victoria Street, London, E.C.

COST-KEEPING.

For Full Particulars, write—

International Time Recording Co.,

171, Queen Victoria Street, LONDON, E.C.,

And 19, Waterloo Street, GLASGOW.

The "DEY" TIME REGISTER

IS ESPECIALLY SUITABLE FOR ENGINEERING ESTABLISHMENTS.

The following is a specimen of the kind of letter we are receiving every day. Hundreds of others of a similar nature can be seen by calling upon us:

JOHN FOWLER & CO. (LEEDS) LTD.,
Engineers.

[illegible]

Steam Plough & Locomotive Works,
LEEDS, [illegible]

Messrs. Howard Bros.,
Liverpool.

Dear Sirs,

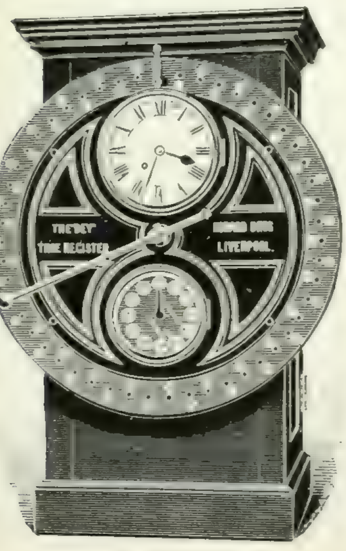
We have now used the "DEY" TIME REGISTERS in our works for over five years (since December, 1897), and they have proved a profitable investment to us and a convenience to our workmen.

We have entirely done away with the old system of time-tickets and the men are perfectly satisfied that their time is correctly noted, and if any dispute arises, a glance at the Register soon convinces them who is at fault. We consider the "DEY" Machine a cheap and thoroughly reliable Time Recorder, and its use an advantage to all employers of labour, both large and small. The machines are easily understood and very simple and accurate in working. The time is recorded by each individual, and our 1,600 men record their time in about four minutes. We are now using eleven machines, some of them being at the entrance gates and others fixed in different shops. We also use one for outside work on large jobs. We find them an invaluable adjunct both in the Cost Department and Time Office.

We shall be glad to allow anyone interested in the subject to see them in actual work.

We now enclose you an order for three more machines, making fourteen altogether, and shall be glad if you will let us have them as soon as possible.

Yours truly,
(for) JOHN FOWLER & CO. (Leeds) Ltd.
(Signed) W. SHELDON,
Manager.



Full particulars from the Proprietors and Manufacturers

HOWARD BROS.,

10, St. George's Crescent, LIVERPOOL.

[illegible]

London Offices : 100c, Queen Victoria Street, E.C.

[illegible]

HOW THE

Card System may be Applied.

APPLICATION NO. 3.

The following diagrams show how a PERFECT RECORD may be kept of all catalogues received, and the subjects dealt with, likely to prove of interest to you in your business.

CATALOGUE INDEX
By Names.

A systematic arrangement of catalogues, providing for instant reference to any desired one, is a very important requisite of a large business house. Fig. 19 illustrates a card used in indexing catalogues by names of publishers. The catalogues are numbered and placed in drawers which have numerical labels, and a card is made out for each catalogue showing the name of the publishers, the number of catalogue and drawer in which it is filed. The card also provides for a brief mention of the articles described in the catalogue which are of more especial interest to the firm indexing same.

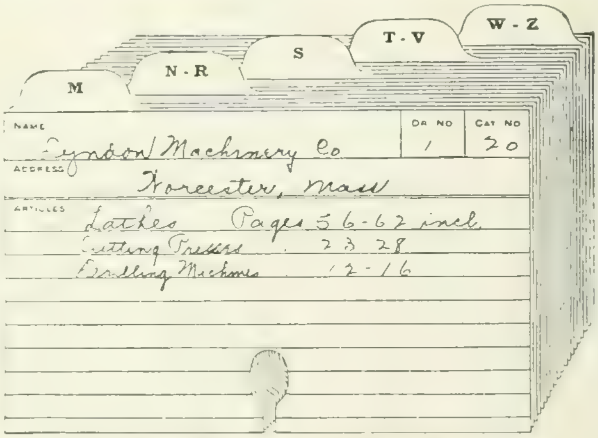


Fig. 19. Guides from a set of 10 Alphabetical Subdivisions.

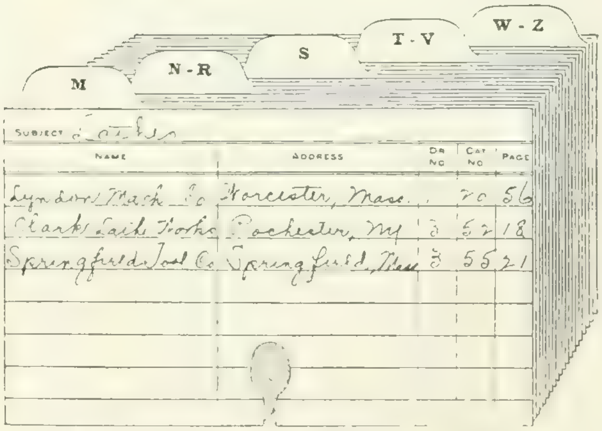


Fig. 20. Guides from a set of 10 Alphabetical Subdivisions.

CATALOGUE INDEX
By Subjects.

A cross index to subjects may be had by making out a card for each subject and entering on same the names of the concerns whose catalogues come under that head, the number of drawer in which each catalogue is filed, the catalogue number, and the pages referring to that subject. Name and subject cards are filed together, a distinction being obtained by using different coloured cards for the two forms. To explain, see illustrations: "Lyndon Mfg. Co." and "Lathes" both come under "L," as both begin with that letter, while "Clark Lathe Works" would be filed after the guide card "C."

This is only one of the many ways in which the Card System can be used. If you will drop us a line we shall be pleased to show you how it may be adapted to your own business.

THE SHANNON Ltd.,

CARD INDEX SPECIALISTS,

F. W. SCHAFER,
Managing Director.

Ropemaker St., LONDON, E.C.

The

"McINNES-DOBBIE"

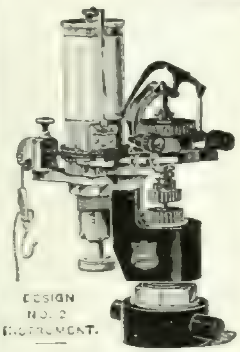
PATENT **Indicators**

for

HIGH & LOW SPEEDS.

In Two Types:—

External Spring and Enclosed Spring



DESIGN No. 2 INSTRUMENT.

EXTERNAL PRESSURE SPRING TYPE.

SPECIAL INDICATORS & Explosion Recorders for Gas & Motor Engines, etc.

Sole Makers: **DOBBIE McINNES, LD.**

INDICATOR MAKERS TO THE ADMIRALTY,

45, Bothwell Street, GLASGOW,

& at Greenock, South Shields, & London.

THERMO-ELECTRIC THERMOMETERS.

of voltmeter, reading to 1,600 degrees Centigrade. Each division on the ... £13 17s. 0d. ... £12 17s. 0d.

The Cambridge Scientific Instrument CO., LTD., CAMBRIDGE, ENGLAND.

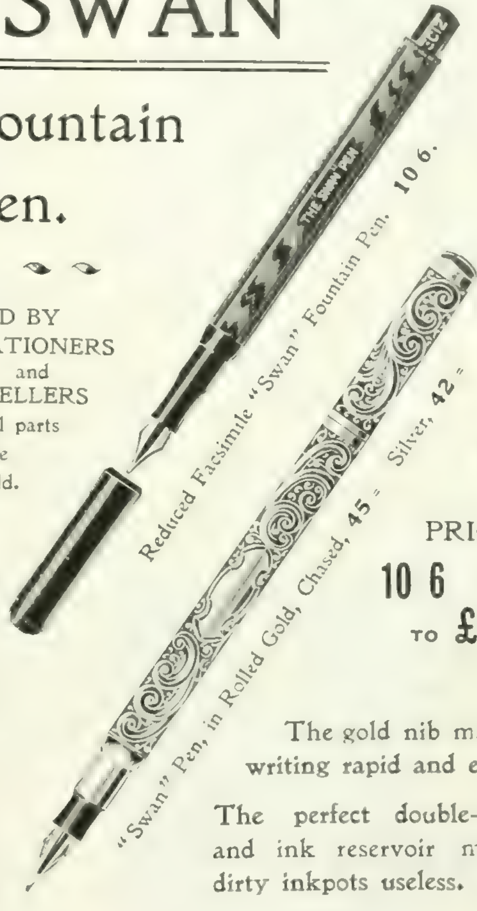
London Office: 92, Hatton Garden, E.C.

"He who works with bad tools is thrice tired."

FOR WRITING the only perfect tool is a . . .

"SWAN" Fountain Pen.

SOLD BY STATIONERS and JEWELLERS in all parts of the World.



Reduced Facsimile "Swan" Fountain Pen. 10/6.

"Swan" Pen, in Rolled Gold, Chased, 45/- Silver, 42/-

PRICES 10/6 TO £20.

The gold nib makes writing rapid and easy.

The perfect double-feed and ink reservoir make dirty inkpots useless.

SUPPLIED IN ALL POINTS. Broad easy running for correspondence. Fine for draughting.

CATALOGUE POST FREE.

MABIE, TODD & BARD,

93, Cheapside, LONDON, E.C.

BRANCHES:

95a, Regent Street, W.; and 3, Exchange Street, Manchester. And at New York, Chicago, and Paris.

THE VERTICAL LETTER FILING SYSTEM

Is an outcome of the Card System, and has similar economical advantages. It provides a definite place for each correspondent's letters, or for papers on any specific subject. Letters are filed methodically and accurately, and can be found instantly when required.

Send for
VERTICAL SYSTEM CATALOGUE, SECTION "E."
If you are interested in Card System Methods, send for
CARD SYSTEM CATALOGUE, SECTION "D."

LIBRARY SUPPLY Co., Bridge House, 181, Queen Victoria Street, LONDON, E.C.

Cabinet and Joinery Works—Walthamstow, Essex.

The "Referee" Front Filing System in use.

EXPERTS IN BUSINESS SYSTEMS AND MODERN OFFICE EQUIPMENT.

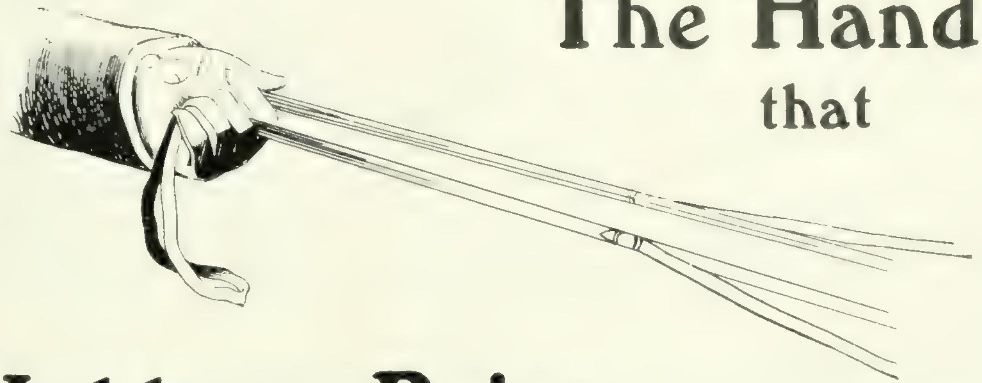
ARE YOU LOOKING ?-

For a simple, direct system of **Letter Filing** without any complications — a system that will enable you to file and find your letters more quickly than by any other existing method, and which is both economical and efficient? **IF SO,** you will find the "Referee" Front Filing System answer all your requirements. It is the simplest and most practical system of letter filing for general purposes on the market.

PARTRIDGE & COOPER, LTD.

Show Rooms: 1 & 2, CHANCERY LANE, LONDON, E.C.

The Hand that



Holds the Reins

needs the eye that loses sight of no material point.

Managerial responsibility in these days can be reduced 50 % by using the L.B. Card System.

It will help you to know what each of your employees is doing—where the rein may be tightened with advantage, and where relaxed.

It will bring together in one place every material point, and ensure the smooth running of the whole concern.

LIBRARY BUREAU, Ltd.,

10, Bloomsbury Street, London, W.C.

BRANCHES:

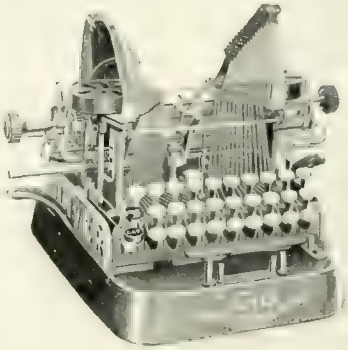
12, Exchange Street, MANCHESTER.
58, The City Arcades, BIRMINGHAM.
Union Buildings, St. John Street, NEWCASTLE-ON-TYNE.

Watch your Work! Don't Trust to Chance.

THE

OLIVER

TYPEWRITER



WRITES IN SIGHT

And your work is always before you.

A Time Saver! A Business Builder!

The STANDARD VISIBLE WRITER

Used by leading Engineering Firms, including—

LLOYD & LLOYD, Ltd.; BABCOCK & WILCOX, Ltd.; STURTEVANT ENGINEERING CO.; JAMES KEITH & BLACKMAN, Ltd.; VICKERS, SONS & MAXIM, Ltd.; MERRYWEATHER & SONS, Ltd.; MELDRUM BROTHERS, Ltd.; EDISON & SWAN UNITED, Ltd.; JOHNSON & PHILLIPS; JOHN DEWRANCE & CO.; BRITISH WESTINGHOUSE CO., Ltd.; MARSHALL, SONS & CO.

Is not this good testimony?

SEND FOR CATALOGUE—

Oliver Typewriter Company, Ltd.,

75, QUEEN VICTORIA STREET, LONDON, E.C.

WEEKLY. ILLUSTRATED. PRICE 6d.

"THE SHIPPING WORLD"

Written by Experts. *Illustrated by Artists.*

ANNUAL SUBSCRIPTION, UNITED KINGDOM 21s.
OTHER COUNTRIES - - - - - - - - 28s

Contains the best and most informing illustrated literature regarding

Naval Architecture.

Marine Engineering.

Commercial & Shipping

Questions of the Day.

THE SHIPPING WORLD, Ltd.,
Effingham House, Arundel St., Strand,
LONDON, W.C.

Crown 8vo. cloth (over 1,200 pages).
Price, United Kingdom, 5s., Foreign Countries, 6s., Post Free.

SEVENTEENTH YEARLY EDITION.

THE SHIPPING WORLD YEAR-BOOK

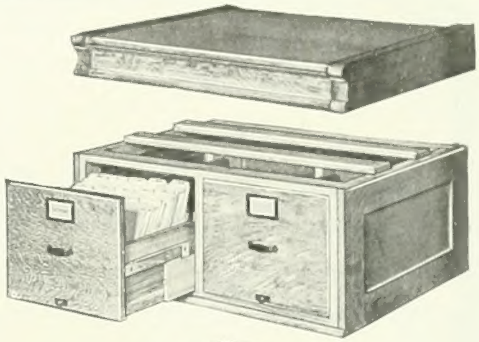
Edited by MAJOR EVAN ROWLAND JONES.

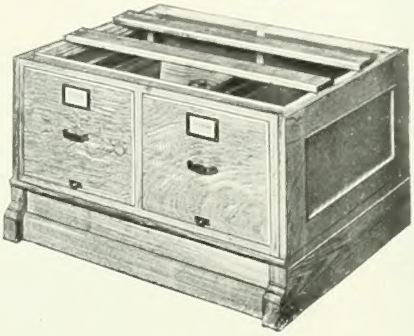
CONTAINING

The Tariffs of all Nations;
A Port Directory of the World;
A Digest of Merchant Shipping Acts,
&c., &c.

To be obtained at THE SHIPPING WORLD Offices, and from all Newsagents.

The Latest Development in . . . Letter-Filing Appliances.





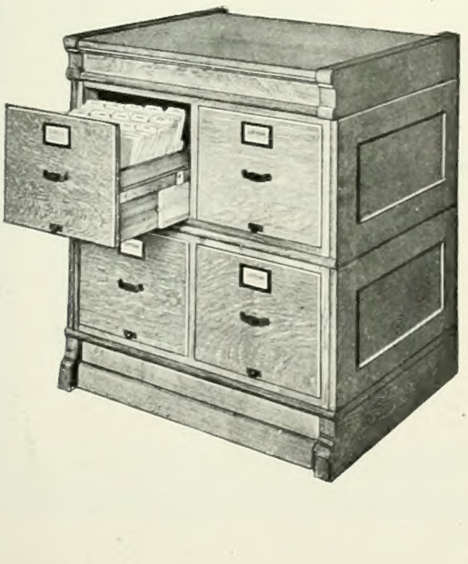
OUR BUILDING-UP CABINETS

The Cabinets grow with your Business.

Are Indispensable for the VERTICAL FILING of all

CORRESPONDENCE,
INVOICES,
CATALOGUES, etc.

They are of British Manufacture throughout.



Full Particulars on application to

The LYLE COMPANY, LTD.,

Card System & Office Experts,

Harrison St., Gray's Inn Road,

LONDON, W.C.

Branch Office:

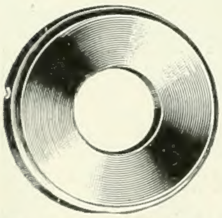
94, Market Street, MANCHESTER.

TEON

THE BEST BELT FOR EXPOSED SITUATIONS.

BELTING

NOT AFFECTED BY STEAM, HEAT, OR COLD.



WASHERS

Made of Cold Rolled Steel, Bright all over, Turned & Chamfered Edges.

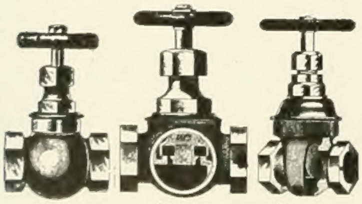
For Bolts of Diameters ...	¼	⅜	½	⅝	¾	⅞	1 in.
Price per Gross	1/2	1/8	2/2	3/1	4/3	5/-	5/9

Sample Washer and Price List will be sent Free on application to—

JARDINE, Raleigh Street, NOTTINGHAM.

BRITISH STEAM SPECIALTIES, LTD.,

LEICESTER, & 73, FARRINGDON RD., LONDON, E.C.



No. 1. No. 2. No. 12.

VALVES ALL TYPES.

No. 1. Standard Globe Valve.

¾in.	1in.	1¼in.	1½in.	2in.
4/-	5/6	9/-	11/6	16/-

No. 2. Renewable Disc Globe Valve.

¾in.	1in.	1¼in.	1½in.	2in.
5/6	7/-	10/-	13/-	20/-

No. 12. Standard Fullway Gate Valve.

¾in.	1in.	1¼in.	1½in.	2in.
4/-	6/-	8/-	11/-	16/-

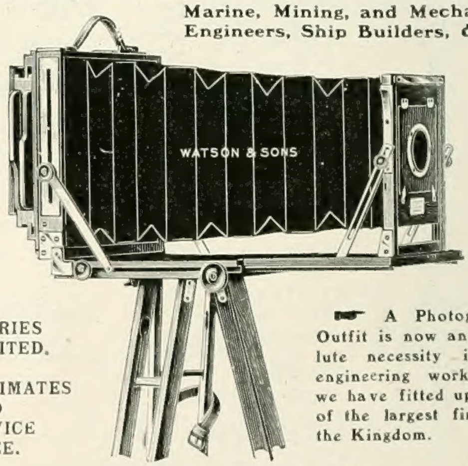
LIBERAL DISCOUNT.

W. WATSON & SONS'

Engineers' Photographic Outfits.

Specially designed and selected with particular reference to the varied requirements of all classes of . . .

Marine, Mining, and Mechanical Engineers, Ship Builders, &c.



INQUIRIES SOLICITED.

ESTIMATES AND ADVICE FREE.

A Photographic Outfit is now an absolute necessity in all engineering works, and we have fitted up many of the largest firms in the Kingdom.

Full Photographic Catalogue (200 pages), on application Department I.

W. WATSON & SONS,
313, HIGH HOLBORN, LONDON;
And 16, FORREST ROAD, EDINBURGH.

Opticians to H.M. Government.

There's NO Reason Why

WASTE HEAT FROM STEAM BOILERS

Should be THROWN AWAY.

Makes STEAMING EASY.

Gives INCREASED EFFICIENCY.

Saves 15 to 25% In COAL.

It's Valuable and can be Utilized.

This Picture explains how it's done.

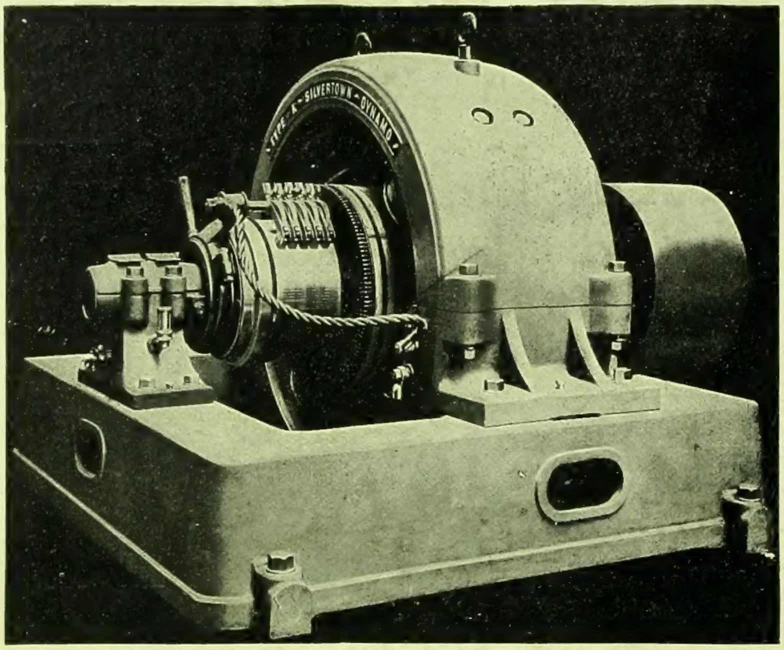
Write us. We'll advise how to convert this Loss into Gain.

E. GREEN & SON, LTD., WAKEFIELD,

Also at LONDON, MANCHESTER, and GLASGOW.

Telegrams: "ECONOMISER."

The INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS



Co., Ltd.,

Offices :

106, Cannon St.,

LONDON, E.C.

Works :

SILVERTOWN,

LONDON, E.

The POWER-GAS CORPORATION LTD.,

39, VICTORIA STREET, LONDON, S.W., and STOCKTON-ON-TEES.

PRODUCER=GAS SPECIALISTS,

And MANUFACTURERS of

PRODUCER-GAS PLANT for POWER & HEATING,

WITH OR WITHOUT AMMONIA RECOVERY

UNDER MOND, DUFF AND TALBOT PATENTS.

Printed for the Proprietors by SOUTHWOOD, SMITH & Co., Limited, Plough Court, Fetter Lane, London, E.C., and Published at Clun House, Surrey Street, Strand, London, W.C.